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U. S. DEPARTMENT OF AGRICULTURE

WEATHER BUREAU

CHARLES F. MARVIN, Chief

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MONTHLY WEATHER REVIEW

VOLUME 44, No. 12

DECEMBER, 1916

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NOTICE TO CONTRIBUTORS.

Contributions intended for publication in any given issue of the MONTHLY WEATHER REVIEW (e. g., January) should be in the hands of the Editor before the end of the next following month (e. g., February), if no illustrations are required. When the paper is illustrated, the manuscript and the copy for the illustrations must be submitted much earlier, in order to permit copy being prepared for the engraver by the end of the month.

REPRINTS are made up without covers in the original size and pagination of the REVIEW. They will not be furnished unless specifically REQUESTED WHEN THE MANUSCRIPT IS SUBMITTED.

MONTHLY WEATHER REVIEW

CLEVELAND ABBE, jr., Editor.

VOL. 44, No. 12.
W. B. No. 605.

DECEMBER, 1916.

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INTRODUCTION.

As explained in this introduction during 1914, the MONTHLY WEATHER REVIEW now takes the place of the Bulletin of the Mount Weather Observatory and of the voluminous publication of the climatological service of the Weather Bureau. The MONTHLY WEATHER REVIEW contains contributions from the research staff of the Weather Bureau and also special contributions of a general character in any branch of meteorology and climatology.

SUPPLEMENTS to the MONTHLY WEATHER REVIEW are published from time to time.

The climatological service of the Weather Bureau is maintained in all its essential features, but its publications, so far as they relate to purely local conditions, are incorporated in the monthly reports "Climatological Data" for the respective States, Territories, and colonies.

Beginning August, 1915, the material for the MONTHLY WEATHER REVIEW has been prepared and classified in accordance with the following sections:

SECTION 1.—*Aerology.*—Data and discussions relative to the free atmosphere.

SECTION 2.—*General meteorology.*—Special contributions by any competent student bearing on any branch of meteorology and climatology, theoretical or otherwise.

SECTION 3.—*Forecasts and general conditions of the atmosphere.*

SECTION 4.—*Rivers and floods.*

SECTION 5.—*Seismology.*—Results of observations by Weather Bureau observers and others as reported to the Washington office. Occasional original papers by prominent students of seismological phenomena.

SECTION 6.—*Bibliography.*—Recent additions to the Weather Bureau library; recent papers bearing on meteorology.

SECTION 7.—*Weather of the month.*—Summary of local weather conditions; climatological data from regular Weather Bureau stations; tables of accumulated and excessive precipitation; data furnished by the Canadian Meteorological Service; monthly charts Nos. 1, 2, 3, 4, 5, 6, 7, 8, the same as hitherto; Meteorological Summary and chart No. 9 of the North Atlantic Ocean for this month in 1915. Owing to the fact that ocean meteorological data are frequently not available for a considerable time after the close of the month to which they relate, the chart and text matter in connection therewith appear one year late.

In general, appropriate officials prepare the seven sections above enumerated; but *all students of atmospherics are cordially invited to contribute such additional articles as seem to be of value.*

The voluminous tables of data and text relative to local climatological conditions, that during recent years were prepared by the 12 respective "district editors," are omitted from the MONTHLY WEATHER REVIEW, but collected and published by States at selected section centers.

The data needed in Section 7 can only be collected and prepared several weeks after the close of the month designated on the title-page; hence the REVIEW as a whole can only issue from the press within about eight weeks from the end of that month.

It is hoped that the meteorological data hitherto contributed by numerous independent services will continue as in the past. Our thanks are specially due to the directors and superintendents of the following:

The Meteorological Service of the Dominion of Canada.
The Meteorological Service of Cuba.
The Meteorological Observatory of Belén College, Habana.
The Government Meteorological Office of Jamaica.
The Meteorological Service of the Azores.
The Meteorological Office, London.
The Danish Meteorological Institute.
The Physical Central Observatory, Petrograd.
The Philippine Weather Bureau.

The Weather Bureau desires that the MONTHLY WEATHER REVIEW shall be a medium of publication for contributions within its field, but such publication is not to be construed as official approval of the views expressed.

CORRIGENDA.

1911. May.
p. 793, col. 1. The expression for the probable error of the correlation coefficient should read: $0.674\frac{1-r^2}{\sqrt{n}}$
p. 794, col. 2. Line 21 *should read:* "is 729.22. The algebraic sum of column 8 is -502.5, this divided by $729.22 = -0.69$, quite a high . . ."
p. 794. Diagram numbered "Fig. 1" should be "Fig. 2."
p. 795. Diagram numbered "Fig. 2" should be numbered "Fig. 1."
September, 1916.
p. 511, col. 1. Equation (4) should read $E_r = 0.674\frac{1-r^2}{\sqrt{n}}$
October, 1916.
p. 567, col. 2, lines 8 and 9. *for* "$E_r = \pm 0.12$" *read* "$E_r = \pm 0.082$"
November, 1916.
p. 615, col. 1, line 15. *for* "longitude" *read* "latitude."

SECTION I.—AEROLOGY.

SOLAR AND SKY RADIATION MEASUREMENTS DURING DECEMBER, 1916.

By HERBERT H. KIMBALL, Professor of Meteorology.

[Dated: Washington, D. C., Jan. 26, 1917.]

For a description of instrumental exposures, and an account of the methods of obtaining and reducing the measurements, the reader is referred to the REVIEW for January, April, and May, 1916, **44:** 2, 179–180 and 244, respectively.

The monthly means and departures from normal values given in Table 1 show that direct solar radiation intensities averaged slightly below normal at Washington, D. C., and Lincoln, Nebr., and slightly above normal at Madison, Wis., and Santa Fe, N. Mex.

Skylight polarization measurements made at Washington on seven days give a mean of 58 per cent and a maximum of 63 per cent on the 10th. These values are only slightly below December averages for Washington. Measurements were not made after the 10th, on account of the presence of snow on the ground.

TABLE 1.—*Solar radiation intensities during December, 1916.*

[Gram-calories per minute per square centimeter of normal surface.]

Washington, D. C.

Date.	Sun's zenith distance. 0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass. 1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
Dec. 2			1.24	1.14	1.07	1.01	0.95	0.88	0.81	0.75
5			1.19							
6			1.34	1.21	1.14	1.06	0.99	0.95	0.91	0.87
7			1.27	1.17	1.06	0.97	0.91	0.80	0.75	0.68
8			0.96	0.85	0.81	0.74	0.65	0.58	0.53	0.48
10			1.36							
12			1.06							
13				0.96						
14					1.21	1.12	1.06	1.01	0.93	0.88
16			1.31	1.12	1.01	0.85	0.80	0.72	0.63	
17			1.12							
26				1.27	1.20	1.14	1.09	1.05	0.99	
29			1.05	0.91						
Monthly means			1.19	1.08	1.07	0.98	0.92	0.86	0.79	0.73
Departure from 9-year normal			−0.03	−0.04	+0.03	+0.01	+0.04	+0.06	+0.06	+0.13
P. M.										
Dec. 2				1.06	0.94	0.85	0.75	0.67	0.62	0.58
5				1.04						
6				1.19	1.11	1.04	0.96	0.89	0.82	0.78
7				1.18	1.12	1.05	0.97	0.91	0.86	0.80
8				0.81	0.73	0.66	0.60	0.56	0.54	0.52
9					1.22	1.15	1.10	1.04	0.97	0.88
16					1.11	0.97	0.96	0.88	0.81	0.73
21					0.87	0.70				
29					0.73	0.61	0.51			
Monthly means				1.06	0.98	0.88	0.84	0.82	0.77	0.72
Departure from 9-year normal				−0.08	−0.06	−0.06	−0.04	−0.04	−0.02	−0.02

TABLE 1.—*Solar radiation intensities during December, 1916*—Continued.

Madison, Wis.

Date.	Sun's zenith distance. 0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass. 1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
Dec. 5				1.37	1.29	1.21	1.14	1.08	1.03	
18					1.31					
21					1.33	1.25	1.17	1.10	1.04	0.98
22					1.27	1.16				
23				1.27						
27				1.32	1.21	1.11	1.04	0.99	0.95	0.89
28				1.44	1.35	1.27	1.18	1.06	1.02	0.96
29				1.42	1.36	1.27	1.19	1.14	1.09	1.03
30				1.19						
Monthly means				1.34	1.30	1.21	1.14	1.07	1.03	0.96
Departure from 7-year normal				+0.07	+0.09	+0.06	−0.01	+0.01	+0.10	+0.07
P. M.										
Dec. 5					1.31	1.25	1.19			
9						1.25				
18					1.26					
23					1.19					
27					1.19	1.13	1.01			
28					1.33	1.27				
Monthly means					1.26	1.22	(1.10)			
Departure from 7-year normal					−0.02	+0.07	+0.07			

Lincoln, Nebr.

Date.	Sun's zenith distance. 0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass. 1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
Dec. 7							0.96	0.88	0.81	
9				1.31	1.26	1.17		1.14	1.10	
22							1.12	1.05	0.95	
27				1.16	1.11	1.03	0.90	0.82	0.75	
29				1.35	1.27	1.10	0.98	0.89	0.80	
30				1.36	1.33	1.25		1.08	1.01	
Monthly means				1.30	1.24	1.14	0.99	0.98	0.90	
Departure from 2-year normal				−0.04	−0.03	−0.03	−0.05	−0.02		
P. M.										
Dec. 1			1.43	1.31	1.21					
4			1.35	1.25	1.23	1.15	1.06	0.99	0.91	
8			1.48	1.46	1.42	1.34	1.26	1.21	1.17	1.14
14				1.39	1.34	1.09				
15				1.37						
26				1.25	1.16	1.07	1.01	0.97	0.92	
29				1.34						
Monthly means			1.42	1.34	1.27	1.16	1.11	1.06	1.00	(1.14)
Departure from 2-year normal			+0.03	+0.01	+0.01	−0.01	−0.02	−0.04	−0.04	+0.18

TABLE 1.—*Solar radiation intensities during December, 1916*—Continued.

Santa Fe, N. Mex.

Date.	Sun's zenith distance. 0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass. 1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
Dec. 1	.....	.....	.....	.....	.....	.....	1.37	.....	.....	.....
5	.....	.....	1.46	.....	.....	.....	.....	.....	1.19	.....
8	.....	.....	1.58	1.51	1.41	1.30	.....	.....	.....	.....
14	.....	.....	1.53	.....	1.36	.....	1.21	1.13	.....	1.11
15	.....	.....	1.58	1.47	1.44	1.40	1.34	1.28	1.22	1.17
16	.....	.....	1.59	1.53	.....	.....	.....	.....	.....	.....
18	.....	.....	.....	.....	1.42	1.36	1.30	1.24	.....	1.15
Monthly means	.....	.....	**1.55**	**1.50**	**1.41**	**1.35**	**1.30**	**1.22**	**(1.20)**	**1.14**
Departure from 5-year normal	.....	.....	**+0.04**	**+0.06**	**+0.03**	**+0.04**	**+0.04**	**+0.04**	**+0.04**	.....
P. M.										
Dec. 5	.....	.....	.....	1.39	1.32	1.26	.....	.....	.....	.....
14	.....	.....	.....	1.45	.....	.....	.....	.....	.....	.....
15	.....	.....	.....	.....	1.41	1.31	.....	.....	.....	.....
Monthly means	.....	.....	.....	**(1.42)**	**(1.36)**	**(1.28)**	.....	.....	.....	.....

Table 3 shows about the normal amount of radiation for the month at Washington and Lincoln, and an excess of about 11.5 per cent at Madison.

TABLE 2.—*Vapor pressures at pyrheliometric stations on days when solar radiation intensities were measured.*

Washington, D. C.			Madison, Wis.			Lincoln, Nebr.			Santa Fe, N. Mex.		
Dates.	8 a.m.	8 p.m.	Dates.	8 a.m.	8 p.m.	ates.	8a. m.	8 p.m.	Dates.	8 a.m.	8 p.m.
1916.	*Mm.*	*Mm.*	1916.	*Mm.*	*Mm.*	1916.	*Mm.*	*Mm.*	1916.	*Mm.*	*Mm.*
Dec. 2	3.00	3.00	Dec. 5	3.15	2.74	Dec. 1	3.00	3.30	Dec. 1	2.36	2.16
5	7.29	8.48	9	2.16	1.78	4	4.57	3.99	5	3.15	3.45
6	1.96	2.74	18	0.51	0.79	7	3.00	2.36	8	0.97	1.37
7	3.63	3.81	21	0.38	0.46	8	1.37	1.19	14	1.60	1.19
8	3.99	4.95	22	0.46	0.86	9	1.19	1.19	15	1.12	1.68
9	10.59	2.36	23	0.81	1.24	14	0.48	1.24	16	1.60	1.24
10	1.88	2.16	27	0.91	1.07	15	1.02	1.68	18	1.45	1.52
12	4.75	2.62	28	0.58	0.74	22	1.19	1.60	.....	.....	.....
13	2.26	1.96	29	0.46	0.74	26	3.81	1.45	.....	.....	.....
14	1.68	2.16	30	0.66	1.24	27	0.86	1.68	.....	.....	.....
16	0.97	1.52	.....	.....	.....	29	0.97	1.78	.....	.....	.....
17	1.68	2.74	.....	.....	.....	30	0.91	2.26	.....	.....	.....
21	4.95	5.36	.....	.....	.....	.....	.....	.....	.....	.....	.....
26	2.36	2.74	.....	.....	.....	.....	.....	.....	.....	.....	.....
29	1.60	1.96	.....	.....	.....	.....	.....	.....	.....	.....	.....

For the year 1916 Washington shows a deficiency of 6,201 calories, or 4.8 per cent, all of which occurred during the first seven months of the year. Madison shows an excess of 3,701 calories, or 3 per cent, all of which occurred during the last six months of the year, and most of it during the months of July and August, which were unusually hot and dry in the upper Mississippi Valley.

TABLE 3.—*Daily totals and departures of solar and sky radiation during December, 1916.*

[Gram-calories per square centimeter of horizontal surface.]

Day of month.	Daily totals. Washington.	Madison.	Lincoln.	Departures from normal. Washington.	Madison.	Lincoln.	Excess or deficiency since first of month. Washington.	Madison.	Lincoln.
1916.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
Dec. 1	92	210	226	− 90	76	36	− 90	76	36
2	235	159	146	55	26	− 42	− 35	102	− 6
3	112	158	172	− 65	26	− 14	−100	128	− 20
4	172	50	206	− 3	− 81	21	−103	47	1
5	158	190	190	− 15	60	7	−118	107	8
6	252	159	174	80	29	− 8	− 38	136	0
7	235	40	177	65	− 89	− 4	27	47	− 4
8	204	36	242	35	− 93	62	62	− 46	58
9	103	174	202	− 65	45	23	− 3	− 1	81
10	245	151	148	79	21	− 30	76	20	51
11	26	77	174	−139	− 53	− 3	− 63	− 33	48
12	105	107	198	− 59	− 23	22	−122	− 56	70
13	208	218	209	45	88	34	− 77	32	104
14	220	221	227	57	90	53	− 20	122	157
15	90	164	196	− 72	33	23	− 92	155	180
16	252	98	203	90	− 34	30	− 2	121	210
17	219	193	101	57	61	− 71	55	182	139
18	61	206	190	−100	73	18	− 45	255	157
19	199	164	113	38	31	− 59	− 7	286	98
20	164	156	200	3	22	28	− 4	308	126
Decade departure							**− 80**	**+288**	**+ 75**
21	180	220	201	19	85	28	15	393	154
22	169	165	197	8	30	24	23	423	178
23	208	183	130	48	47	− 43	71	470	135
24	126	51	207	− 34	− 86	33	37	384	168
25	153	76	70	− 7	− 61	−104	30	323	64
26	223	30	202	63	−108	27	93	215	91
27	23	203	206	−137	64	30	− 44	279	121
28	34	207	175	−127	67	− 2	−171	346	119
29	194	206	218	33	65	40	−138	411	159
30	181	190	204	20	48	25	−118	459	184
31	202	161	68	41	18	−112	− 77	477	72
Decade departure							**− 73**	**+169**	**−34**
Excess or deficiency since first of year. Gr.-cal.							**−6,201**	**+3,701**	.....
Excess or deficiency since first of year. Per cent							**−4.8**	**+3.0**	.....

SECTION II.—GENERAL METEOROLOGY.

CURRENT EVAPORATION OBSERVATIONS BY THE WEATHER BUREAU.

By B. C. KADEL and C. ABBE, Jr.

[Dated Weather Bureau, Washington, Jan. 18, 1917.]

INTRODUCTORY.

The Weather Bureau has been engaged for the past two years in gradually installing at various points in the United States a chain of uniformly equipped stations for the measurement of evaporation losses from water confined in metal pans. Friendly cooperation on the part of State agricultural colleges, private irrigation interests, Weather Bureau officials, and others has permitted the work to progress to a degree that warrants the belief that the results being secured will be of considerable value to engineers, climatologists, botanists, plant physiologists, foresters, and others; and as arrangements have been made to publish the observational material monthly, it seems proper to record here the stations at which evaporation observations are now being made as well as to give some account of their equipment, their operation, and the places of publication. A list of these stations, known as "class A evaporation stations," now in operation is given in Table 1 and their locations indicated on figure 6. Their equipment and operation are briefly described in the following paragraphs.[1] The observations at each of these 24 stations are limited to one daily measurement of the loss due to evaporation from a pan of water, the daily wind movement across the pan, and such other meteorological observations as will serve to identify the general climate of the region.

TABLE 1.—*Class "A" evaporation stations of the Weather Bureau in operation Jan. 1, 1917. (See also figure 1.)*

Stations by States.	Latitude (north).	Longitude (west).	Approximate altitude of pan above sealevel.	Date of first observation.
	° ′	° ′	*Feet.*	
Arizona:				
Roosevelt	33 40	111 09	2,275	Nov. 25, 1915
California:				
Tahoe	39 10	120 09	6,230	July 1, 1916
District of Columbia:				
American University	38 56	77 05	392	Apr. 18, 1915
Idaho:				
Arrowrock Reservation	43 36	115 55	3,230	June 17, 1916
Deer Flat Reservation	43 35	116 42	2,510	Mar. 13, 1916
Kansas:				
Lawrence	38 58	95 15	1,018	Aug. 7, 1916
Tribune	38 28	101 46	926	Aug. 16, 1916
Maine:				
Gardiner [a]	44 14	69 46	130±	June 4, 1915
Missouri:				
Columbia (University of Missouri campus)	38 57	92 20	738	Apr. 1, 1916
Columbia (University of Missouri golf links)	38 57	92 20	.....	Apr. 15, 1916
Montana:				
Bozeman	45 40	111 03	4,754	July 1, 1916
Valier	48 25	112 20	.....	July 1, 1916
New Mexico:				
Elephant Butte	33 10	107 10	4,475	Apr. 14, 1916
Santa Fe	35 41	105 57	6,975	May 18, 1916
Tucumcari	35 10	103 48	4,200	July 1, 1916
Nevada:				
Indian Springs	36 31	115 43	3,136	June 25, 1916
Lamolle	40 27	115 25	6,100	July 1, 1916
Marlette Lake	39 10	119 55	7,900	Sept. 15, 1916
Ohio:				
Wooster	40 47	81 56	1,030	June 11, 1916
Porto Rico:				
San Juan	18 29	66 07	48	May 29, 1916
South Dakota:				
Rapid City	44 04	103 12	3,240	May 1, 1916
Texas:				
Austin (Hill's ranch, land pan)	30 14	97 41	475	Mar. 9, 1916
Austin (Hill's ranch, floating pan)				
Washington:				
Walla Walla	46 02	118 20	1,000	May 16, 1916

[a] Observes at 7 a. m. and at 6 p. m., all other stations observe but once a day at about 7 a. m. local time.

EQUIPMENT.

In order to insure comparable observational results from many different portions of our country the entire equipment has been worked out with a view to securing the greatest practicable uniformity of exposure conditions and of equipment. Each station presents essentially the appearance of the one illustrated in the accompanying figure 1; a plan is shown in figure 2.

Each station is equipped as follows:

1 evaporation pan, 4 feet by 10 inches, with its support. (See fig. 5.)
1 still-well, with a 4-inch carpenter's bench level. (See fig. 3.)
1 hook-gage. (See fig. 4.)
1 fence.
1 supply tank (covered), where required.
1 raingage, Weather Bureau 8-inch, with wooden support and measuring stick.
1 shelter, Weather Bureau cotton-region pattern. (See fig. 1.)
1 pair maximum and minimum thermometers, with their support.
1 anemometer, Weather Bureau Robinson, with a special support.

The pan.—The standard evaporation pan is cylindrical in form, 10 inches deep, 48 inches in diameter, inside dimensions. It is made of 22 B. W. G. iron, galvanized *before* the pan is made up. The bottom is turned up and riveted to the sides. The top, or rim, is fitted with a $\frac{1}{8}$ by 1 inch galvanized iron hoop securely riveted to the pan.

The still-well.—The standard still-well, designed by B. C. Kadel and adopted by the Weather Bureau, consists of a triangular galvanized cast-iron base, 12 inches on each side by $\frac{1}{2}$ inch thick with a levelling screw 3 inches long at each corner, and the well proper 8 inches high and $3\frac{1}{2}$ inches outside diameter, made of seamless brass tubing rigidly mounted on this triangular base. The water is admitted to the well by means of a short length of standard $\frac{1}{8}$-inch brass pipe extending through the cast-iron base. (See fig. 3.)

A 4-inch carpenter's bench level is provided for testing the horizontality of the top of the still-well.

The hook-gage.—The micrometer evaporation hook-gage shown in accompanying figure 4 was specially designed by Prof. Charles F. Marvin for evaporation work.

[1] More complete details are given in: *Weather Bureau.* Instructions for the installation and operation of class "A" evaporation station. By Benj. C. Kadel. Washington. 1915. 28 p. illus. 8°. (Instrument Division, Circular L.)

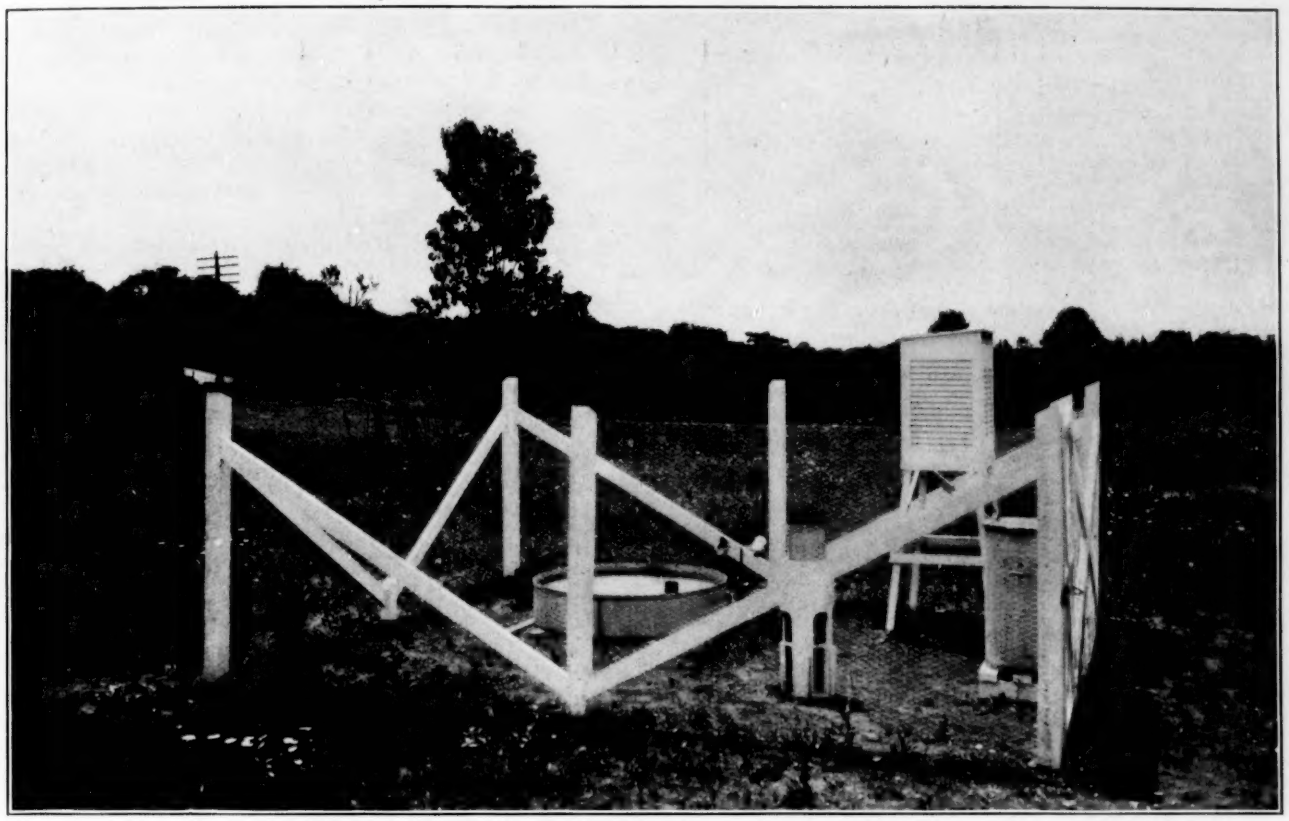

FIG. 1.—General view of a Weather Bureau standard Class A evaporation station.
(American University, District of Columbia.) (See also fig. 2.)

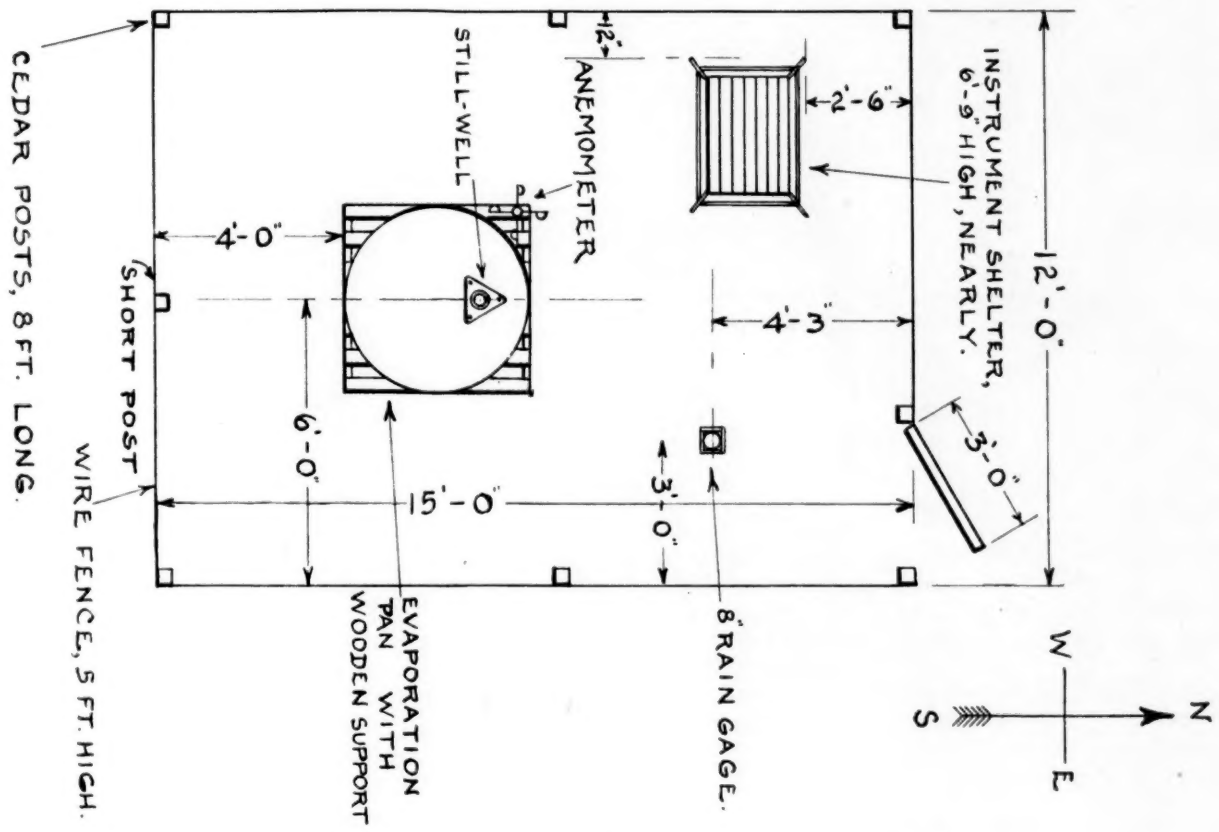

FIG. 2.—Plan of a Weather Bureau standard Class A evaporation station. (See also fig. 1.)

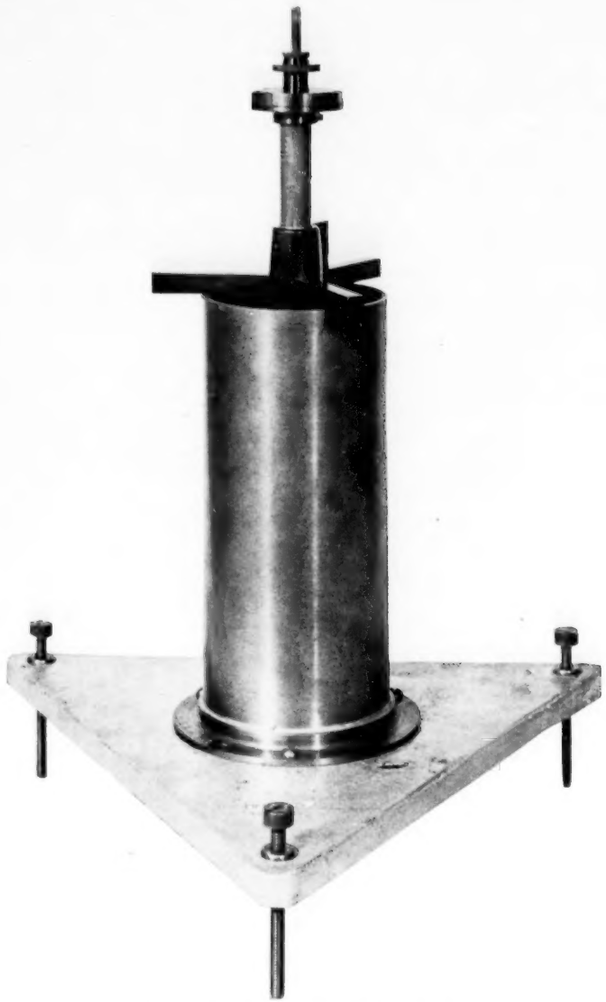

FIG. 3.—Still-well with hook-gage in position.

FIG. 4.—Micrometer evaporation hook-gage.

It is so constructed that one complete revolution of its micrometer screw head moves the hook vertically through exactly $\frac{1}{10}$ inch. The inches and tenths are graduated on the casing or tube, and the hundredths and thousandths are on the micrometer screw head.

Supply water tank.—This is needed only where the water supply is so far distant that an appreciable error would result from the long time required to bring water to fill the pan. The tank, when present, is kept covered to prevent its contents influencing the vapor over the evaporation pan.

Instrument shelter.—This is the standard louvered Weather Bureau shelter issued to cooperative stations. It screens the maximum and minimum thermometers supplied to the station. Both the shelter and its support are painted white in all cases.

Raingage.—The standard Weather Bureau 8-inch gage consists of a funnel 8 inches in diameter, a brass measuring tube whose cross section is $\frac{1}{10}$ the area of the funnel receiver, and an overflow can of galvanized iron. (See Instrument Division Circular B and C, for accounts of thermometers and raingage.)

The anemometer support.—In the present outfit this support is a simple brass casting which combines a brass pin with a flange adapted to being fastened to the wooden support of the evaporation pan.

INSTALLATION OF EQUIPMENT.

Exposure.—The instructions for selecting the site of the evaporation station read as follows:

Select a comparatively level location, representative of the region and open to the sunshine all day, if possible. If hills, trees, buildings, etc., can not be avoided, the length of time the pan is shaded morning and evening should be indicated in the description of the station. In order to be free from possible reflected heat the pan should be no nearer to any tree, building, cliff, or other object than the height of the object. Nearness to ponds and swamps, particularly when such ponds or swamps are temporary in character, should be avoided, as a rule, but it may at times be desirable to expose pans near a body of water or even on a raft floating in the water. Such exposures should be carefully described so that the results may be correctly interpreted when comparison of the records of one station are made with those of another.

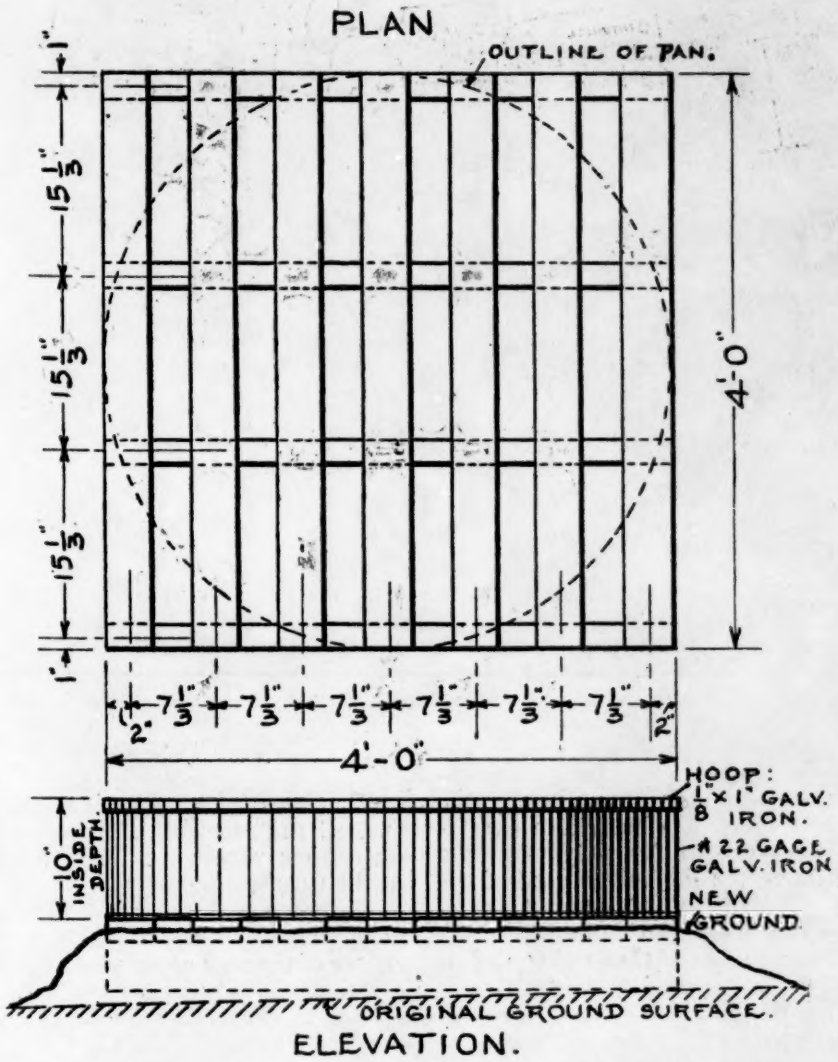

FIG. 5.—Plan and elevation of a Weather Bureau standard evaporation pan on its support.

Grass and weeds in the immediate neighborhood of the station should be cut occasionally.

The arrangement of the equipment for these standard stations is shown in figures 1 and 2. The rectangular plot of open ground, 12 by 15 feet in size, is inclosed by a 5-foot fence of 1-inch mesh woven wire stretched taut between eight braced posts.

The wooden support for the evaporation pan is laid on the ground with the low side blocked up to make it level, then it is filled up within an inch of the top with ground brought from a distance, and this is well tamped in. Thus drainage is assured, and a desirable slight circulation of air underneath the pan is permitted. (See fig. 5.)

FIG. 6.—Map showing locations of Weather Bureau standard Class A evaporation stations that were reporting on January 1, 1917. (See also Table 1, p. 674.)

The pan is placed on the wooden support with care that the pan bottom does not buckle when pressed downward, particularly in the region to be occupied by the still-well. When thus set in place the bottom of the 10-inch-deep pan stands not less than 6 inches, and its rim not less than 16 inches above the general surface of the inclosure.

The still-well is placed within and about a foot from the north side of the pan; it is so adjusted that the top of its brass cylinder is level in two mutually perpendicular directions. It is found best to have the triangular still-well base rather high on the leveling screws; and it is kept standing in place in the pan continuously to avoid errors incident to careless placing before each reading.

The anemometer support is fastened to the northwest projecting corner of the pan's wooden support. This position brings the anemometer cups with their centers 6 inches above the rim of the pan at a point that permits the shadows of the cups to fall on the pan only during late afternoon.

The thermometer shelter is mounted on its standard support in such a manner that the shelter door opens to the north, and is located just far enough within the northern fence to permit the door to swing clear. Its standard support is designed to bring the shelter floor 4 feet above the ground at each station; and to bring the thermometer bulbs 5½ feet above the general level of the inclosure.

MANNER OF OBSERVING.

The time of observation is uniformly within half an hour of 7 a. m., local standard time; and whatever hour is fixed upon within this limit, is adhered to at the station in the future.

Evaporation measurement is made by placing the hook-gage (fig. 4) into the still-well with the hook near the center of the well as shown in figure 3; then, with the hook standing slightly below the level of the water, the final setting is invariably made by causing the point of the hook to rise slowly until it just pierces the water surface, making the smallest possible pricking. The observer is encouraged to test his readings by making several successive settings, removing the hook-gage and changing the position of the hook between each pair of settings.

After a setting has been made, the gage is removed from the still-well to read and the reading is at once recorded on the blank form provided.

The evaporation pan is kept filled with clean fresh water to within 2 inches (50.8 mm.) of the rim, and it is refilled at a regular observation when the water level has receded 1 inch (25.4 mm.). The depth of water in the pan is thus maintained at between 7 and 8 inches at all stations, while space for a reasonably heavy rainfall is also available.

Overflow and resultant loss of record due to heavy rain, is to be foreseen and guarded against by the timely re-

Form No. 1024. **U. S. DEPARTMENT OF AGRICULTURE, WEATHER BUREAU.**

Record of evaporation and meteorological conditions during the month of July, 1915;
Station, Amer. Univ'y, D. C.; *Latitude,* 38° 54'; *Longitude,* 77° 03'; *Meridian time used,* 75th;
Evaporation tank ____ *inches deep,* ____ *inches diameter, filled to approximate depth of* 8 *inches; description of station filed,* at Office of the Weather Bureau, Washington, D.C.

DATE.	Exact Time of Observation.	Number of Hours Since Last Observation.	Meteorological Conditions. Air Temperature. Max.	Min.	Set Max.	Mean.	Precipitation.* Character.	Began.	Ended.	Amount.	Wind. Anemometer Dial Reading.	Since Last Observation. Total Movement.	Prevailing Direction.	Evaporation. Gage Reading.	Gage Reading When Tank Filled.	Actual Amount, (†)
			F°	F°	F°	F°				In.	Mi.	Mi.		In.	In.	In.
1	7:00 a	24	82.1	65.6	70.6	72.6	R	DN	DN	0.550	362	48		2.920	*	0.286
2	7:00 a	24	86.1	66.2	74.4	75.2	R	DH	DN	0.035	403	41		2.726		0.229
3	7:00 a	24	84.3	64.9	70.8	73.3	R	DN p.	D N p.		475	72		2.420		0.306
4	7:00 a	24	84.5	62.6	68.2	71.8				0.050	501	26		2.301		0.169
5	7:00 a	24	82.3	68.2	68.8	73.1	R	DN a	9:30 a	0.200	562	61		2.327		0.174
30																
31																
Sums	(a)	(a)					(a)	(a)	(a)		(a)		(a)	(a)	(a)	
Means	(a)	(a)					(a)	(a)	(a)	(a)	(a)			(a)	(a)	

8—2300

(a) No data required. *Including rain, hail, sleet, and melted snow. †Last gage reading plus precipitation minus present

(IN TRIPLICATE.) Observer, George F. Hawk Address,

FIG. 7.—Illustration of entries on form used by Class A evaporation stations.

moval of a sufficient amount of water, making hook-gage readings before and after such removal. The pan is emptied and stored during the season of freezing temperatures.

The anemometer is read once daily at the observation hour, and the total wind movement of the past 24 hours is recorded.

The prevailing direction of the wind is determined by means of frequent eye observations on the movement of smoke, bending of tree twigs, etc., and the entry made at the time of the evaporation observation refers to the prevailing direction since the last entry. When the wind has blown from various directions the entry "variable" (var.) is made.

The temperature observations are made in the usual Weather Bureau manner, by means of the maximum and minimum thermometers exposed in the shelter shown in figure 1. Readings are made and entered at the regular observation hour (about 7 a. m.) and obviously give the air temperature only.

The recording form supplied and used is best understood by the sample extract shown in figure 7.

PUBLICATION OF OBSERVATIONS.

As remarked in the introduction, the Weather Bureau has been engaged in these installations during the past two years; indeed, the first observations according to this system were made at the Weather Bureau station on the American University campus, District of Columbia, beginning April 18, 1915. On December 12, 1916, the Chief of Bureau issued a circular announcing that the evaporation data now being collected will, thereafter, be published in the monthly State Section Reports, i. e., "Climatological data by [State] sections" (not the same as another publication of data by sections bearing the same title but also known as Weather Bureau Bulletin "W"). All evaporation observations of this current series made under the direct supervision of the Weather Bureau during 1915 and 1916 will be published in the Annual Summary for 1916 of the "Climatological Data by [State] Sections" for the appropriate State.

A detailed description of each station will be published in the respective issues which contain the first data for the station. These descriptions will not be repeated in subsequent issues unless changes in a station occur. The temperature, cloudiness, and wind direction will appear in the regular tables of climatological data as now published in these section reports, but the daily evaporation measurements and wind movements, together with any other special data will be placed in a separate table of a form similar to that now used for the daily temperature extremes.

SLOPE AND VALLEY AIR TEMPERATURES.

By WILLIAM R. BLAIR, Professor of Meteorology.

[A short time ago the Weather Bureau received a communication asking for information that will help orchardists to avoid the known cold valley floors, to seek out the warmer zones along the valley slopes, to find the spots that are warmest just before sunrise, etc. The following reply was prepared and is here reprinted [1] for the readers of the REVIEW.—C. A., jr.]

The more important factors entering into the temperature conditions experienced in a given locality are:

[1] *See* U. S. Reclamation service. Reclamation Record, January, 1917, 8:40-41.

(1) The effect of the earth's surface in heating or cooling the air in contact with it; (2) the heating or cooling of air adiabatically when there is a downward or upward component in the air's motion; (3) the heating or cooling of the air itself by its absorption and reradiation of heat radiated to it, mostly from the earth's surface; and (4) the carrying in of colder or warmer air from other locations by whatever wind may be blowing at the time these temperature conditions are being considered.

During insolation the earth's surface in the valley, on the slopes and on the mountain tops is being heated by the absorption of the sun's rays. During day and night the earth's surface is being cooled by the radiation of its heat to the air above it and to space. The air near the earth's surface is clearer, i. e., freer from dust and moisture, at night than during the day and consequently absorbs less terrestrial radiation at night than during the day. The earth's surface and the air in contact with it, i. e., the air in which we live and in which trees and plants live, is warmest at 3 to 4 p. m. and coldest just before sunrise, as a rule, markedly so in clear, calm weather.

In cloudy weather the clouds screen the earth's surface from the sun's radiated heat to a greater or less extent, depending on the cloudiness, and prevent, more or less, the escape of the earth's radiated heat to the air above them and to space. Diurnal extremes of temperature are not pronounced in cloudy weather, and therefore any discussion of valley, slope, and summit temperatures with reference to late spring and early autumn frosts need concern itself with clear weather only.

When the wind prevailing on a given occasion is blowing in such direction and at such rate as to keep the air moving fairly rapidly over the earth's surface in the location in question, there is less likelihood of very low minimum or very high maximum temperatures during the day than if the air were allowed to remain for a longer time under the cooling or heating influence of the earth's surface. It is in clear, calm weather conditions that frosts are most likely to occur. It often happens that winds are directed at, or nearly at, right angles to ranges of mountains or hills. At such times wind velocities may be high on the mountain tops but comparatively low in the valleys, especially if the latter are narrow. This is one reason why valleys are more subject to frosts than are nearby plain areas at approximately the same level.

At 3 to 4 p. m. the temperature of the air next the earth's surface is, as a rule, at a maximum in the valley, on the slope, and on the mountain top, and the maximum is the more pronounced in clear, quiet weather conditions. Under the heating influence of the earth's surface at this time of day the air on the slopes and on the mountain tops is warmer than the free air over the valley at the same level. The circulation attending this distribution of temperature will be a nearly vertical interchange of the air on the valley floor with that just above it and a nearly horizontal interchange of the air on the slopes with the free air over the valley, the initiative in this circulation being with the cooler free air over the valley. The initial vertical component of the circulation thus set up is downward, but it changes to upward as it nears the heating surface of the slopes. It is readily seen that the path of this circulation will always be tangent to the earth's surface and will, to an observer on the surface, have the appearance of a breeze blowing from the valley up the slopes to the mountain top; hence the term "valley breeze." While it continues this circulation tends to keep the temperature of the air near the earth's surface down and to increase the temperature of the free air over the valley.

As the sun continues its descent the amount of heat radiated to the air and to space by the earth's surface becomes large compared with the amount of the sun's heat absorbed, and the air in contact with the cooling surface of the earth in the valley floor, the slopes, and the mountain tops becomes cool relative to the free air above the valley. This cooling takes place nearly simultaneously on the valley floor and on the slopes and top of the mountain. Depending on the slope of the valley floor, air resting upon it moves slowly, if at all. Since this air is denser than the warmer air immediately above it, it remains on the valley floor and becomes colder during the night. The warmest part of the air mass contained in the valley at 3 to 4 p. m. was that in contact with the valley floor. As the air in contact with the cooling earth's surface takes up the temperature of that surface the maximum temperature of the air mass over the valley rises gradually during the night. The circulation attending this distribution of temperature will be an interchange of the cool air on the slopes and top of the mountains with the warm mass of free air which we have seen building over the valley earlier in the day and which terrestrial radiation tends to maintain during the night. The initiative in this circulation will be with the cool air of the slopes and mountain tops. This cool air will flow toward the point of maximum temperature in the air mass over the valley provided the maximum temperature is at the same or a slightly lower level, i. e., air of high specific gravity can not displace air of lower specific gravity unless the air of lower specific gravity is at the same or a lower level than the air of higher specific gravity. The vertical component of this circulation will be downward as the cool air leaves the slopes, but upward as the warm free air over the valley is being displaced. It is readily seen that the path of this circulation is tangent to the earth's surface on the slopes and that it will, to an observer on the slope, have the appearance of a breeze blowing down the side of the mountain, hence the term "mountain breeze." While it continues this circulation tends to build up a deeper and deeper mass of cold air in the valley and to keep warmer the air on the slopes above the cold air mass. The depth to which this cold air mass in the valley can build up depends on (1) the width of the valley compared with the height of the mountain on either side; (2) the lengthwise slope of the valley floor; and (3) the relative lengths of day and night. In a relatively narrow valley the cold air mass will be deeper than in a relatively wide valley. The cold air mass will flow down the valley with greater or less velocity, depending on the lengthwise slope of the valley floor. The faster it moves, i. e., the faster the cold air resting on the valley floor drains away, the less deep will be the cold air mass built up in the valley during a clear, quiet night by the process described above.

A little observation on the slopes of a given valley at the time of injurious frosts in the late spring and in the early autumn should therefore serve to determine with sufficient exactness the height on the slopes above which, for some distance at least, the greatest freedom from such frosts will be experienced. The easiest and most direct way of making these observations is to expose thermographs at different altitudes on the slopes. The balloon is not needed because the upper surface of the cold-air mass in the valley is nearly level, possibly a few meters lower over the middle than at the sides of the valley. This upper surface has been found at 100 to

300 meters above the valley floor at different times of the night and in different localities.

It would be an uncertain procedure to apply the observations made in one valley to the conditions in another, except in a general way. The general remarks above are based (1) on three or four years' observations of mountain and valley temperatures in the vicinity of Mount Weather, Va., and (2) on a number of observations by means of captive balloons at Lone Pine and Mount Whitney, Cal. The observations in the vicinity of Mount Weather were summarized with reference to late and early frosts in the Bulletin of the Mount Weather Observatory, volume 5, page 118. This number of the Bulletin was issued in February, 1914. The captive balloon observations at Lone Pine and Mount Whitney, Cal., were published in the MONTHLY WEATHER REVIEW, July, 1914. Another helpful article on this subject, based on the above data, was published in the MONTHLY WEATHER REVIEW for October, 1914, under the title "Air drainage explained." Other observations in the mountain regions of North Carolina have been made by the Weather Bureau in the further study of this subject, but these observations have not yet been published.

LOW PRESSURE AT PARIS, NOVEMBER 18, 1916.[1]

By [CHARLES] ALFRED ANGOT, Director.

[Dated: Bureau Central Météorologique de France.]

On November 18, 1916, there occurred a meterological phenomenon really exceptional in this region. After a period of low pressure which lasted nearly 48 hours, the barometer at Paris fell to a point almost unprecedented. The pressure reduced to sealevel was 722.5 mm. (28.44 inches) at $22^h\ 25^m$ (10:25 p. m.), which corresponds to less than 720 mm. (28.35 inches) in the lowest parts of the city. The extreme minimum observed at Paris, 719.4 mm. (28.32 inches) at sealevel, occurred on December 24, 1821.

Ordinarily barometric depressions pass over the British Isles or farther north, moving almost directly from west to east. The position of the center is usually such that Paris is in the region of violent ocean winds from the south, southwest, and west. This time the center followed an entirely different track. It came from the Gulf of Gascony and at 7^h on the 18th was between Belle Isle and the mouth of the Loire. From there it moved inland across the south of Brittany, turning toward le Mans (Department of Sarthe), where it arrived about 18^h (6 p. m.), then toward le Havre and Dieppe, and finally toward London, where it arrived at 7^h on the 19th. All the coast of the Gulf of Gascony, of Brittany, and the western side of the English Channel experienced violent ocean winds blowing from the west. On the other hand, at Paris, on the right of the track, the wind came from the land; it blew from between the south and southeast and remained relatively moderate. At the top of the Eiffel Tower the wind hardly reached a velocity of 20 meters per second (45 miles per hour) even in squalls at the middle of the night when the barometer first began to rise rapidly, although velocities of 30 to 35 meters per second (67 to 78 miles per hour) are often observed with ocean winds from the west and southwest in the winter storms whose centers pass much farther to the north.

During the time the depression was following an abnormal track its velocity was very slight. From the south of Brittany to London the storm scarcely moved 600 kilometers (373 miles) in 24 hours, or with a mean velocity of 25 kilometers (16 miles per hour). Finally, the period of low pressure was of very long duration, but at the time when the barometer was falling most rapidly the rate of change did not exceed 1.5 mm. (0.06 inch) per hour. All these considerations, and others upon which it is not possible to comment now, explain why at least in the Paris region stronger winds were not observed in spite of a pressure entirely comparable to those often observed in tropical cyclones.

[1] La baisse barométrique du 18 novembre 1916. Comptes rendus, Acad. d'agric. de France, 2:1042-1043. Paris 22 nov. 1916. *Translation* by W. G. Reed.

THUNDER AND HAIL IN THE PARIS REGION.[2]

By [CHARLES] ALFRED ANGOT, Director.

[Dated: Bureau Central Météorologique de France.]

It has been shown that thunderstorms are always a result of atmospheric movements which lead to the formation of cumulo-nimbus clouds. There are often accompanying phenomena such as rain, hail, and electric manifestations, which may be produced simultaneously, but there is no relation of cause and effect between them. The cause of the production of hail can not be seen in the electric manifestations.

In the course of recent investigations there was occasion to tabulate the number of days with thunder and the number of days with hail observed at the Parc Saint-Maur Observatory during the 40 years 1874–1913. Table 1 gives the results.

TABLE 1.—*Number of days with thunder and the number of days with hail, at Parc Saint-Maur, Paris, during (40 years) 1874–1913.*

Months.	Total number of days with—	
	Thunder.	Hail.
January	3	24
February	11	36
March	34	80
April	85	66
May	170	65
June	226	21
July	221	18
August	185	10
September	108	9
October	38	20
November	8	10
December	5	24
Total	1,094	383

In this table only days with true hail have been included, grésil ("soft hail") has been omitted. Part of the decrease in frequency of hail in the summer months appears to be due to the fact that when the hailstones are small they are melted before reaching the ground and are recorded as rain. It is in part for this reason that hail is rare within the Tropics.

In the Paris region hail is more frequent than electric manifestations in Winter; but very much less frequent in Summer. The maximum frequency is in Spring from March to May, specially in March ("April showers"); thunder, on the other hand, is most frequent in June and July.

These data furnish an additional proof of the complete independence of hail and electric phenomena.

[2] *Angot, Charles Alfred.* Le tonnerre et la grêle dans le région de Paris. Comptes rendus, Acad. agric. de France, Paris, Oct. 11, 1916, 2: 912-913. *Translation* by W. G. Reed.

ON THE KINETIC THEORY OF EVAPORATION.[1]

By A. MARCH.

[*Reprinted from* Science Abstracts, Sect. A, Oct. 25, 1916, § 1137.]

The determination of the dependence of the pressure of saturated vapors on temperature has been the object of much theoretical investigation. Those attempts proceeding purely from the thermodynamical standpoint assume the heat of evaporation to be a linear function of the temperature, apply the laws for a perfect gas to vapors, and neglect the specific volume of the liquid in comparison with that of the gas. The general result, known as the Dupré-Rankin equation, is of the form

$$\log p = A - B/T - C\log T,$$

where p is the vapor pressure, T the absolute temperature, and A, B, C, are constants, and this is in excellent agreement with experiment if the values of the constants are determined from observed data. On the other hand, attempts have hitherto failed to deduce the constants from purely theoretical thermodynamical grounds. The present author here considers the theory from the molecular kinetic standpoint. He finds that the heat of evaporation and the specific volume must be determined as functions of the temperature, and to determine the vapor-pressure law he describes at some length a molecular mechanical model based on critical data. The result of the investigation is to establish van der Waal's vapor-pressure formula.—*H. H. Ho[dgson.]*

TEMPERATURE OF THE OCEAN BELOW THE 500-FATHOM LINE ON THE WEST COAST OF AMERICA.[2]

By A. H. CLARK.

[*Reprinted from* Science Abstracts, Sect. A, October 25, 1916, § 1109.]

The observations upon which this discussion is based were made from the *Albatross* off the west coast of America from Chile to the Bering Sea.

The most striking feature of the abyssal temperatures at depths exceeding 2,000 fathoms is the small range of maximum variation, which is about 1°F. The observed temperature at each depth is compared with the average for all the oceans at that depth as obtained by Murray and Hjort, and the following general results are obtained: Temperatures are all above the average from Chile to the Gulf of California, and are all below the average from the Gulf of California to the Bering Sea. They are considerably below the average off southern California and the Gulf of Alaska, and slightly below from central California to Alaska. It is supposed that the equatorial countercurrent flowing eastward is deflected mainly to the south by the California current flowing southward, and that this condition of affairs accounts for the result given.—*R. C[orless].*

[1] Physikal. Zeitschr., July 15, 1916, 17: 299–302.
[2] Jour., Washington acad. sci., 1916, 6: 413–417.

SURFACE CURRENTS OF JUPITER DURING 1915–1916.[3]

By S. BOLTON.

[*Reprinted from* Science Abstracts, Sect. A, Oct. 25, 1916, §1111.]

During the favorable opposition of Jupiter in 1915, 2,139 transits of dark and light markings were obtained between 1915, September 9, and 1916, February 9, made with the 26-inch reflector at Bramley, near Leeds. The more prominent phenomena are tabulated, with the resulting rotation periods. The spots at the southern edge of the north equatorial belt exhibited a marked acceleration of velocity, while the corresponding ones along the north edge of the south equatorial belt moved at the normal rate of 9h. 50m. 27.8 s., the difference between the two currents being 2.9 seconds. The spot charts show the inconsistency of the rates of motion of the individual spots in nearly all latitudes, the longitudinal drift even of the red spot never for any considerable period remaining constant.—*C. P. B[utler.]*

WILLIAM MARRIOTT, 1848–1916.

[*Reprinted from* Nature, London, Jan. 4, 1917, 98: 354–355.]

Meteorology has lost one of its most ardent supporters by the sudden death of Mr. William Marriott at Dulwich, England, on December 28, 1916. He was 68 years of age (born Aug. 9, 1848), and throughout his life had been remarkably free from illness, but latterly heart trouble had developed. Mr. Marriott commenced his meteorological work at Greenwich Observatory in January, 1869, and he left the observatory at the end of 1871. While at the Royal Observatory he was in the magnetic and meteorological department under Mr. James Glaisher, F. R. S., who was very actively associated with the Meteorological Society. Mr. Marriott became assistant secretary to the Meteorological Society in 1872, and he maintained the position until his retirement in September, 1915, after 43 years' service. He had become a member of the society in 1870 while serving at Greenwich. The science of meteorology has steadily developed during the last half century and Mr. Marriott, in his official capacity, took the keenest interest in furthering its advancement. From 1881 to 1911 he edited the Meteorological Record, which contained the monthly results of meteorological observations over England and Wales. For climatological questions the Meteorological Record has afforded material of great value. Since 1911 this work has been taken over by the Meteorological Office. Mr. Marriott was the author of "Hints to Meteorological Observers" (seven editions), a work which constitutes instructions for taking observations, also "Some Facts about the Weather" (two editions). He was a frequent writer for the Quarterly Journal of the Royal Meteorological Society, his contributions dealing with many and very varied subjects.

[3] Roy. Astron. Soc., M. N., May, 1916, 76: 634–636.

SECTION III.—FORECASTS.

FORECASTS AND WARNINGS FOR DECEMBER, 1916.

By H. C. FRANKENFIELD, Supervising Forecaster.

[Dated: Weather Bureau, Washington, D. C., Jan. 17, 1917.]

GENERAL PRESSURE DISTRIBUTION OVER THE UNITED STATES AND CANADA, INCLUDING THE HAWAIIAN AND ALEUTIAN ISLANDS, ALASKA, AND THE MIDDLE ATLANTIC OCEAN.

Over the Hawaiian Islands moderately high pressure prevailed during the first week of December, 1916, with a slight reaction afterward until the 10th, after which normal conditions prevailed until the 17th. A steady fall then set in, reaching its lowest point on the 24th, after which there was a rise to normal conditions that prevailed until the end of the month.

Over the Aleutian Islands, as indicated by the reports from Dutch Harbor, the alternations of pressure were quite rapid and irregular. There was, however, a prolonged period of low pressure covering the 6th to 18th, inclusive, with a brief intermission on the 14th and 15th. After the 19th marked high pressure prevailed for five days, followed by another period of five days of low pressure. At the end of the month pressure was somewhat above normal. Over eastern Siberia high pressure was the rule. It was nearly normal during the first four days of the month, quite high for four or five days thereafter and moderately low on the 11th and 12th, after which a rise set in that steadily increased until the 23d and 24th, when the barometer read 31.10 inches. After that date there was a moderate fall but at the end of the month the pressure was still above normal.

Over Alaska marked low pressure during the first four days of the month was followed by a reaction of a fluctuating character, but nevertheless pronounced, that continued until the 13th, after which time moderately low pressure predominated, followed on the 20th by another period of high pressure until the 28th, inclusive. During the last few days of the month there was a decided fall to much below normal conditions.

The pressure conditions of Alaska were reflected, after the usual time interval, throughout the western portion of the United States. Over the eastern portion of the United States low pressure prevailed quite generally throughout the month until the last few days and, as the text following will show, there were a number of severe storms, mainly of the western type, that swept down into the Gulf States and then turned northeastward. In the Canadian Maritime Provinces pressure was remarkably low throughout the month, with the exception of a very few days when conditions were approximately normal.

The reports from Bermuda and Turks Island show that over the middle and southern portions of the North Atlantic, pressure was fairly steady throughout the month, with the exception of two periods in Bermuda. There pressure was quite low from the 16th to the 19th, inclusive, and high during the last week of the month, with high pressure extending well to the southward over the southern North Atlantic.

WASHINGTON DISTRICT WARNINGS.

On the morning of December 1 a disturbance of fair proportions was central north of Lake Superior with cool high pressure over the South. Moderately strong winds being indicated over the Great Lakes, small-craft warnings were accordingly ordered on the lower Lakes from Cleveland to Oswego, and fresh to strong southwest winds occurred during the day, extending also over the extreme western part of Lake Erie and southern part of Lake Huron. Warnings of possible light frost on the following morning were also issued on the morning of the 1st, for southern Georgia and the South Carolina coast. Light frost occurred on the morning of the 2d over southern Georgia, and light to heavy frosts along the middle Gulf coast.

During the 5th, the greatly increased development of a disturbance while crossing the upper Lakes caused local strong winds of brief duration for which no warnings had been ordered. The disturbance reached the lower St. Lawrence Valley by the morning of the 6th, and northwest storm warnings were ordered from Sandy Hook to Eastport. West and northwest gales followed, except on the northern New England coast, with a maximum velocity of 72 miles an hour at New York City.

Storm of December 5–9.—This storm first appeared on the coast of Oregon on the morning of December 5. By 3 p. m. of the following day it was over Nebraska with steadily increasing intensity, with moderately high pressure to the southeastward and northwestward. Northeast storm warnings were ordered at 5:30 p. m. for Lake Superior, and southeast warnings for Lakes Michigan and Huron. On the morning of the 7th the storm was central over southeastern Minnesota, with a narrow trough of low pressure extending southwestward into Oklahoma, and thence westward into New Mexico. Southeast storm warnings were then ordered for the lower Lakes, and in the early evening the warnings were ordered to be continued on the upper Lakes. The storm did not develop any considerable energy although pressure was quite low (29.60 inches), and only moderately strong winds occurred in a few localities. In the meantime the southwest section of the disturbance moved eastward, and at 8 p. m. of the 7th it was central over northeast Texas with a northeastward movement. Southeast storm warnings were therefore ordered along the Gulf coast from Bay St. Louis to Cedar Keys. Pressure was rising rapidly and decidedly to the westward of the disturbance, accompanied by a marked fall in temperature, and the evening forecasts of the 7th and the morning forecasts of the 8th contained a warning of freezing temperatures in Mississippi during the night of the 8th and much colder weather for the entire South. The southern section of the storm moved rapidly northeastward during the night of the 7th–8th, and on the morning of the 8th it had practically joined the northern section. The storm warnings were then lowered on the upper Lakes and along the Gulf coast. However, during the 8th the storm redeveloped considerably, and at 3 p. m. southwest warnings were again ordered on the lower Lakes. No further warnings were ordered for the upper Lakes at the time, and by the

morning of the 9th pressure had fallen still more over the lower Lakes and north upper Lake region, but as yet without strong winds over the latter section. Northwest warnings were ordered for Lake Huron, the east shore of Lake Michigan, and on Lake Superior from Houghton, Mich., eastward. Gales occurred on the lower Lakes as forecast, but there were no winds of consequence on the upper Lakes. Southwest storm warnings were also ordered on the Atlantic coast from Delaware Breakwater to Portland, and at 3 p. m. the southwest warnings on the lower Lakes were changed to northwest. Only moderately strong winds followed these displays and all warnings were ordered down at 9:30 p. m. of the 9th, the storm having moved northeastward beyond Ontario. As stated above, an extensive high pressure area of considerable magnitude followed this storm, and by the morning of the 8th its eastern quadrants covered the Plains States, with the crest over Colorado. Special observations at 1 p. m. indicated clearing weather in the Gulf and South Atlantic States, and at 2:30 p. m. cold-wave warnings were ordered for southern Kentucky, western Tennessee, and Mississippi, and warnings of freezing temperature and heavy frost for Alabama, western Georgia, and northwest Florida. At 9 p. m. special warnings of frost on the morning of the 10th were sent to central and north Florida. Low temperatures and frosts occurred as forecast except in central and northeast Florida where cloudiness prevented any decided fall in temperature.

Storm of December 8–12.—This disturbance was an offshoot from a more extensive one over the Aleutian Islands, and reached Alberta on the morning of December 8. It moved southeastward to the Texas Panhandle and then turned eastward and northeastward. At 8 p. m. of the 10th, the center was over northwest Arkansas, with pressure falling rapidly to the northeastward, and northeast storm warnings were ordered at 10 p. m. over south Lake Huron and Lake Erie for strong northeast winds and snow on the following day. While the barometer continued to fall during the northeastward movement of the disturbance, reaching 29.42 inches over western New York, no strong winds occurred owing to the approach of another disturbance from the West. However, on the morning of the 12th, the pressure gradients were so marked as to call for northwest storm warnings from Wilmington to New Haven, and northeast warnings from Saybrook Point to Boston, afterwards extended to Eastport, Me. These warnings were not due so much to the northern storm as to a secondary one that first appeared in very faint form on the morning of the 11th at the mouth of the Mississippi River. It moved northeastward with rapidly increasing intensity, and on the morning of the 12th was central off the North Carolina coast with a barometer reading of 29.34 inches. The two storms joined during the day, and at 8 p. m. the single storm was central over eastern Maine with a barometer reading of 28.76 inches at Eastport. Fresh to strong gales, mostly from the northwest, had occurred from North Carolina northward diminishing considerably by the morning of the 13th. The rise in pressure after this storm was not marked, another low pressure system following closely, and cold-wave warnings ordered at 10 p. m. of the 10th for northern Kentucky, Indiana, and western Ohio, were not verified.

Storm of December 12–16.—This storm first appeared on the evening of December 12 over southwestern Montana. By 1 p. m. of the 14th it had moved to southeastern Texas in moderate form, and then turned northeastward. By 8 p. m. of the 14th it had reached southwestern Alabama, and at 10 p. m. northwest warnings were ordered displayed on the Gulf coast from Bay St. Louis, Miss., to Rockwell, Fla., and on the Atlantic coast from Jacksonville to Savannah; also southeast warnings from Charleston to Delaware Breakwater. As a HIGH of considerable strength was following closely, warnings of freezing temperature were issued for the interior and of heavy frosts on the coasts of Mississippi, Alabama, and northwestern Florida, and warnings of cold weather for west Tennessee. The warnings sent to Mobile, Ala., and Pensacola, Fla., were for cold waves, and at 9:30 p. m. cold-wave warnings were also ordered for Alabama, southwest Georgia, and north Florida. Warnings were also issued of heavy frost on the morning of the 16th for central Florida. At 8 a. m. of the 15th the storm was central over the Carolinas, and during the day moderate westerly gales occurred in the districts warned. Northeast storm warnings were also ordered on the morning of the 15th from Atlantic City to Boston, and at 3 p. m. on the remaining portions of the New England coast. By the morning of the 16th, northeast to northwest gales had occurred as forecast, with a whole gale off the New England coast. Eastport, Me., reported a wind velocity of 76 miles an hour from the northeast. At 10 p. m. of the 15th the northeast warnings were changed to northwest from Atlantic City to Boston, and at 10 a. m. of the 16th from Marblehead, Mass., to Eastport. The winds subsided during the 16th, and on the morning of the 17th the storm had passed into the Atlantic Ocean by way of Cape Breton Island.

On the morning of the 15th the cold wave had extended through Alabama and extreme northwestern Florida, and by the following morning throughout the South Atlantic States generally, and into southern Virginia, with freezing temperature in the interior of central Florida, as had been forecast on the evening of the 14th and the morning of the 15th. Warnings of freezing temperature and heavy frost for Georgia and northern and central Florida, repeated on the morning of the 16th, were found on the following morning to have been verified for Florida only, Bartow reporting killing frost with a minimum temperature of 26°. The warning in Georgia failed through the southeastward movement of the high area over Florida.

During the passage of the storm up the Atlantic coast snow fell in considerable quantity, and at 2 p. m. of the 15th a heavy-snow warning was issued for New England and eastern New York. This warning was fully verified. This storm was by far the most severe of the month on the New England and Middle Atlantic coasts. At Eastport, Me., the records of 45 years were exceeded in three particulars: First, the low barometer reading of 28.52 inches; second, the extreme wind velocity of 96 miles per hour; and third, the 24-hour snowfall of 17 inches on the level ground.

Storm of December 14–15.—This storm first appeared on the morning of the 14th over northern Saskatchewan. By 8 p. m. of the 14th it was central over northwest Minnesota, and northeast storm warnings were accordingly ordered for Lake Superior and southeast warnings for Lakes Michigan and Huron. The storm continued eastward over the Lakes, with diminishing intensity, and there were no strong winds except over western Lake Superior.

Storm of December 17–19.—On the morning of the 17th there was a moderate disturbance over northeastern Texas, and it moved southeastward to Louisiana during the day, with increasing intensity. In the evening of that day small-craft warnings were ordered to be displayed on the morning of the 18th from Mobile, Ala., to

Apalachicola, Fla. By the morning of the 18th, however, the storm was over northeast Alabama, with a considerable increase in intensity, and northeast storm warnings were ordered from Boston to Baltimore, southeast warnings from Chincoteague Island, Va., to Wilmington, and southwest warnings from Southport, N. C., to Jacksonville, Fla., with orders to change the latter to northwest at sunset.

Special observations at 1 p. m. indicated that there would be strong northwest winds on the east Gulf coast, and at 3 p. m. northwest storm warnings were ordered from Carrabelle to Tampa, Fla. The disturbance was then over South Carolina with an apparent northeastward movement, and the northeast storm warnings on the New England coast were therefore extended to Eastport, Me. The 8 a. m. forecast of the 18th also contained warnings of heavy snow for southern New England and the Middle Atlantic States, and the storm warnings of the afternoon were supplemented by an additional warning to all coast stations concerned to exercise great caution, as severe gales with heavy snow were probable north of Virginia. However, the storm center moved off the North Carolina coast, more to the eastward than had been anticipated, and as a result there were no gales nor snow of consequence north of New Jersey. Warnings of heavy snow issued on the morning of the 18th for western New York, western Pennsylvania, and southeastern Ohio also failed of verification, owing to the eastward movement of the southern storm.

The rapid movement of this storm and the equally rapid approach of cold weather from the West necessitated the issue, during the morning and afternoon of the 18th, of cold-wave warnings for eastern Mississippi, Alabama, Georgia, northern Florida and South Carolina, and of heavy frost warnings for central Florida. These warnings were fully verified by the occurrences on the morning of the 19th, by which time the disturbance had passed northeastward beyond New England and the storm warnings had been lowered.

Storm of December 18–23.—The next disturbance from the northwest developed in very irregular shape. It appeared first on the morning of December 18 over northern British Columbia, and by the morning of the 19th it extended in crescent shape from western Montana southeastward to the Texas Panhandle and thence northeastward to Lake Michigan, with a strong and very cold HIGH to the northward. Cold-wave warnings were therefore ordered for northern Michigan, but they failed entirely of verification, owing to the persistence of the northeastern section of the disturbance. The northwestern section of the disturbance continued southeastward with increasing intensity, and on the morning of the 20th it was central over Arkansas, with a northeastward movement. Anticipating this movement, cold-wave warnings had been ordered on the previous evening for Kentucky, Indiana, southwestern Ohio, lower Michigan, western Tennessee, and Mississippi. These warnings were repeated on the morning of the 20th, for Mississippi, Tennessee, Kentucky, and Indiana.

On the evening of the 20th, with the storm central over Mississippi and a moderate secondary disturbance over northwestern Ohio, cold-wave warnings were ordered for West Virginia and southwestern Pennsylvania. These warnings also failed of verification, owing to the slow movement of the southern disturbance and of the high pressure to the westward. On the evening of the 21st the disturbance was over northeast Alabama, with an apparent northward movement. During the night, however, there was an extraordinary development, both in intensity and velocity of progress, and on the morning of the 22d the disturbance was over eastern Maryland in pronounced form, attended by general rains and snows but as yet without strong winds. Southeast storm warnings had been ordered on the morning of the 20th from Bay St. Louis, Miss., to Cedar Keys, Fla., but no strong winds resulted, owing to the limited development of the storm while in the South.

There had also been some indication of a further storm development in the southeast during the 21st, and at 6 p. m. of that day southeast storm warnings were ordered from Charleston to Fort Monroe, and strong south winds occurred as forecast. On the morning of the 22d, with the storm central over Maryland, northwest warnings were immediately ordered from Hatteras, N. C., to New London, Conn., and northeast warnings on the remainder of the New England coast.

The storm continued northeastward during the 22d and at 8 p. m. was central over Maine, with a pressure of 28.76 inches at Portland, and severe westerly gales had occurred, with a maximum of 88 miles an hour at New York City and 72 miles an hour at Block Island. The storm soon passed beyond the borders of the State of Maine and the warnings were lowered on the following morning.

A high-pressure area of fair proportions followed this storm, attended by another decided fall in the temperature over the Ohio Valley and the South. On the evening of the 21st cold-wave warnings were ordered for western Tennessee, Alabama, Georgia, northern Florida, South Carolina, and western North Carolina, and on the morning of the 22d for the greater portions of the upper Ohio Valley, the middle and the southern Atlantic States. These warnings were well verified in the South but only partially so elsewhere, although the temperatures were much below the seasonal average.

Storm of December 19–25.—This storm first appeared off the North Pacific coast on the evening of December 19 and by the night of the 25th had reached southeastern Colorado, with steep pressure gradients to eastward and southeastward. Small-craft warnings were therefore ordered to be displayed on the following morning over the middle Gulf coast. By that time, however, the storm had separated into three sections—one over western Colorado, with diminishing intensity, one over eastern South Dakota, moving northward with increasing intensity, and a third over eastern Texas. Owing to this latter secondary disturbance the small-craft warnings were changed to southeast storm warnings at 11 a. m. of the 26th, from Bay St. Louis, Miss., to Rockwell, Fla., and northeast warnings were ordered from Fort Monroe, Va., to Jacksonville, Fla. By the morning of the 27th the northern section was central over eastern Manitoba with about the same intensity and with the southern section still over the west Gulf States, with apparently diminishing intensity, but with some evidences of further development. The high-pressure area over the Atlantic Ocean and adjacent States had fallen materially, and no strong winds of consequence occurred on the southern North Atlantic coast.

As pressure had risen rapidly in the rear of the main disturbance, accompanied by marked fall in temperature to much below normal conditions, cold-wave warnings were ordered for upper western Michigan, lower Michigan, except along the west shore, northwestern Ohio, Indiana, southern Kentucky, western Tennessee, and northern Mississippi. These warnings were well verified as to Michigan but only partially so over the remaining sections where ordered.

Advisory warnings of strong winds, with snow, were sent to the upper ports of Lake Michigan on the 19th, 23d, and 25th; the two latter were fully verified, while the first one failed.

OTHER DISTRICT WARNINGS DURING DECEMBER.

Chicago district.—The month was marked by temperature above the normal during the first week over practically the entire district, while during the balance of the month, with only slight interruptions, the readings were below, so that for the month as a whole the temperature averaged below the seasonal normal. The departures in the Northwest were considerable, ranging in Montana and North Dakota from 8 to 15 degrees.

Warnings were issued on the morning of the 10th for cold waves for the western portion of the district, and these were extended eastward over the greater portion of the district during that day and evening. At the same time cautionary warnings were issued to the western ranchmen to protect their cattle on the ranges, as snow and strong winds were anticipated in addition to the fall in temperature. Colder weather quickly overspread the entire district, but the severe cold was retarded so that the cold wave was not felt in full force in the Northwest until the 12th.

Warnings were issued on the 17th and again on the 19th for cold waves which moved directly southward over the Plains States from the British northwest, causing very low temperatures as far south as the Kansas border by the 20th. The waves finally extended eastward over the entire district with considerable intensity.

Following the movement of these cold waves, a severe storm developed in the West, which later proved to be by far the most important of the entire month. It appeared on the north Pacific coast on the 20th and gradually pushed southeastward over the plateau, crossing the Rocky Mountain region on the 25th. The storm then took an unusual course northeastward, moving first across the northern Plains States to Manitoba, thence directly eastward. The depression was rather deep, and attendant storm conditions were correspondingly severe. Special warnings were ordered on the 24th, 25th, and 26th, covering the movement of these storm conditions, and live-stock warnings were issued to the western ranges on the 25th. The snowfall in some of the Western States was especially heavy, and because of accompanying high winds drifted badly.—*H. J. Cox, Professor of Meteorology.*

New Orleans district.—A decided cold wave overspread the district on December 8 and 9, for which timely warnings were issued.

Special observations at 1 p. m. on the 10th showed a storm area centered over Oklahoma with decided anticyclonic weather to the northwestward; therefore, cold-wave warnings were ordered at 3:30 p. m. for stations in Oklahoma and at Bentonville, Ark., and Abilene, Tex., and at 10 p. m. were extended to Fort Smith, Ark. The anticyclonic conditions diminished in intensity and the warnings were only partially verified.

Cold-wave warnings were ordered at 9:45 p. m. on the 12th for Altus and Oklahoma and on the morning of the 13th for Little Rock. The low temperatures moved southward more slowly than was anticipated and the warnings were not fully verified.

An area of low pressure over eastern Texas with an area of high pressure over the Plains States on the morning of the 14th, gave a cold wave over eastern Texas and Louisiana on the 14th and 15th for which timely warnings were issued.

An intense cold wave reached the northwestern portion of the district on the morning of the 20th and passed over the southeastern portion of the district on the morning of the 22d. Cold-wave warnings were ordered at all stations well in advance of the cold wave.

Cold-wave warnings were ordered on the 25th for Oklahoma, Arkansas, and the interior of Texas, in the expectation that an area of low pressure centered over southwestern Kansas and extending southward over western Texas would move eastward and carry southward the cold air from the Missouri Valley and the Plains States. On the morning of the 26th the LOW was centered over eastern South Dakota and the warnings failed of verification.

Storm warnings ordered for the Texas coast on the 8th and 14th and the Louisiana coast on the 20th were justified. Small-craft warnings were displayed on the Louisiana coast on the 14th, 18th, and 20th and on the Texas coast on the 19th and were followed by winds which justified the display.

Fire-weather warnings were telegraphed to the forest supervisors, Harrison and Hot Springs, Ark., and Cache, Okla., on the 10th, 19th, and 25th and the conditions forecast occurred.—*I. M. Cline, District Forecaster.*

Denver district.—Moderately warm weather prevailed throughout the district until the morning of December 7, when the temperature fell sharply in western Colorado, southern Utah, and northern Arizona, following the rapid eastward passage of a disturbance from the north California coast. Cold-wave warnings were issued for eastern Colorado and eastern New Mexico, a part of the disturbance remaining over New Mexico. On the morning of the 8th temperatures fell to 4 to 10 degrees above 0°F. in eastern Colorado and northeast New Mexico, and 8 to 12 degrees below the freezing point in southeast New Mexico, amply justifying the warnings issued. A depression was central over the Texas Panhandle at 8 a. m. on the 10th, and warnings of a cold wave attended by snow were issued for eastern Colorado. Temperatures of 0° to 8° F. prevailed 24 hours later in eastern Colorado, and snow fell except at Pueblo, Colo. A cold high pressure area appeared over Saskatchewan on the 12th. Special observations at 1 p. m. disclosed a rapid southward movement and cold-wave warnings were issued for northeastern Colorado. At 8 p. m. these warnings were extended to southeastern Colorado. Temperatures ranging from 0° to 8° and 12° followed in eastern Colorado. A cold-wave warning was issued for Denver and vicinity at 8 a. m. December 17. By 9 p. m. of the same date the temperature at Denver had fallen to 8°F. Cold-wave warnings were issued for southeast New Mexico at 8 p. m. of the 17th, and a temperature of 16° below the freezing point was recorded at Roswell, N. Mex., the following morning. On the morning of the 19th a trough of low pressure overlay the eastern Rocky Mountain slope, with an anticyclone over Manitoba and eastern North Dakota. Generally this pressure distribution is not favorable for a cold wave in eastern Colorado, but it was expected in this instance that the greater part of the LOW would move into the lower Mississippi Valley and make way for rising pressure in eastern Colorado. On the morning of the 20th the weather was 20 to 30 degrees colder in eastern Colorado, with temperatures ranging from near 0° in the plains of eastern Colorado to 14° near the foothills. At 8 p. m. of the 19th the warnings were extended to eastern New Mexico. During the next 36

hours temperatures ranging from 0° to 12° occurred in eastern New Mexico, with 0° temperatures in eastern Colorado. At 8 p. m. on the 20th the warnings were repeated for southeast New Mexico and the temperature at Roswell fell 44 degrees within 12 hours.

An energetic storm appeared over eastern Nevada on the evening of the 24th, and warnings of heavy snowfall were issued for southern Utah, northern Arizona, and southwest Colorado, with a cold wave for Utah and portions of Colorado and Arizona. The warnings of heavy snowfall were fully verified, the snowfall ranging from 4 to 10 inches and upward, attended by low temperature. Christmas morning the storm was over Utah with a barometer reading of 29.12 inches at Modena. Cold-wave warnings were issued for Utah, Colorado, northern and western Arizona, and northwest New Mexico. The warnings were justified, temperatures below 0°F. being reported in portions of Colorado and Utah and freezing temperatures in southwestern Arizona on the 26th. Remarkably low temperatures continued in portions of Utah and Arizona during the remainder of the month. The Christmas storm caused serious delays in railroad operation, and considerable suffering occurred owing to the tardy receipt of coal and of foodstuffs. Heavy snowfall warnings were extended to northern New Mexico and eastern Colorado, but the snowfall at reporting stations was not heavy.

Frost or freezing temperature warnings were issued almost daily for portions of southern Arizona. No extensive damage was reported in this region, although temperatures well below freezing occurred on several dates.—*Frederick W. Brist, Assistant Forecaster.*

Portland, Oreg., district.—December, 1916, was unusually cold with less than the normal amount of precipitation. From the 6th to the 19th and again on the 26th and 27th the weather in this district was mostly controlled by high-pressure areas. The weather from the 2d to the 5th and from the 21st to the 25th was under the influence of North Pacific LOWS. During the last four days a LOW was central at sea near the mouth of the Columbia River. The barometer at the coast stations fell rapidly on the 27th and 30th and rose rapidly between these dates. This LOW was about to move inland when it surged back to sea without causing as much wind or rain as expected.

Storm warnings were ordered at one or more stations on 17 occasions, cold-wave warnings were ordered twice for portions of the district, and small-craft warnings were ordered four times. The storm warnings ordered during the first three days were fully verified, as maximum wind velocities of 80 miles an hour occurred at both Tatoosh Island and North Head. Storm warnings ordered on the 7th were followed by maximum wind velocities of 60 miles at North Head and 52 miles at Tatoosh Island.

On the 10th storm warnings were ordered displayed at the entrances to the Strait of Juan de Fuca and the Gulf of Georgia, as the barometric gradients were very steep between Tatoosh Island and Prince Rupert, with a 60-mile gale blowing at Prince Rupert. This storm moved rapidly eastward to Alberta without causing any high winds in this district. Storm warnings were ordered on the 18th and 19th which were not followed by verifying velocities at the coast stations, but high winds occurred at inland seaports.

Storm warnings were ordered during the early afternoon of the 19th in consequence of special observations received from Seattle and Tatoosh which showed a marked fall in pressure during the last two hours. A low-pressure area was central, that morning, over western British Columbia but did not appear to have sufficient energy to warrant the display of storm warnings. When the special observations were received it was thought a sudden development had taken place and that high winds would occur, as the velocity had already doubled at the two stations sending the special observations. No high winds, however, were reported in connection with this storm.

On the morning of December 21 a well-defined storm was central near the mouth of the Columbia River, and warnings were ordered displayed at all stations in this district. Shortly after these warnings were ordered the barometer began rising rapidly and at noon they were ordered down and small-craft warnings ordered up in their place, except at Marshfield where the storm warnings were continued. The highest wind during the passage of this storm was 56 miles, from the northwest, at North Head, Wash. It would have been better if small-craft warnings only had been displayed.

Storm warnings were ordered again on the 22d at all stations in this district, but no high winds occurred at any of the land stations. The barometer fell rapidly and a reading of 29.20 inches was reported at Tatoosh Island, Wash., on the morning of the 23d. The isobars inclosing this storm were wide apart at its center and close together near the outer edge of the depression, which accounts for the wind not being strong in this district. Gales in connection with this disturbance were severe along the California coast and presumably also along the southern Oregon coast.

On the 27th storm warnings were ordered at the entrance to the Strait of Juan de Fuca, and 10 hours later a maximum wind velocity of 48 miles was reported from Tatoosh Island, Wash. The last warning of the month was ordered at 6 p. m. on the 31st at the entrances to the Strait of Juan de Fuca and the Gulf of Georgia. It was followed by wind velocities of 48 miles an hour at Tatoosh Island and 64 miles at North Head.

Cold-wave warnings were ordered for a portion of the district on the 13th and 26th. The one ordered on the 13th was partially verified, but the one on the 26th was a failure, owing to the HIGH losing energy which was not foreseen at the time the warnings were ordered.

The sales manager of the Hood River Apple Growers' Association was advised on the 6th, 10th, 13th, and 25th of approaching cold weather along the Union Pacific Railroad in eastern Oregon and southern Idaho. This association was at the time shipping a large number of cars of apples to the eastern markets. The following extract from a letter received in acknowledgment of this service will show its worth:

> I want to acknowledge receipt of your wires and also at the same time my very keen appreciation of the excellent service. With this information coming from you and from Prof. Cox I am going to be able to guide better the destinies of this organization and the guidance of 2,000 cars of fruit, but I just want you to know how keenly I appreciate it.
>
> WILMER SIEG,
> *Sales Manager, Apple Growers' Association.*

Two special forecasts were sent during the month to the U. S. S. *Cheyenne*, which was cruising along the coast as the mother ship for some submarines that were investigating the facilities of the harbors in Washington and Oregon.—*E. A. Beals, District Forecaster.*

San Francisco district.—From December 1 to 5 the weather was unsettled, and rain with snow in the mountains prevailed in all sections. During the latter part of the first decade and all of the second decade the weather was fair and cold, with frequent killing frosts in all sections.

The third decade was a period of unsettled weather, generally with low temperatures and rapid changes from rain to fair weather at short intervals. During this period killing frosts occurred frequently. The most severe frost occurred on the morning of the 27th in southern California and damaged citrus fruit in some sections, but to what extent is not known at present.

More than the usual number of southerly gales occurred along the coast, and the storm warnings were timely in nearly every instance.—*G. H. Willson, District Forecaster.*

HURRICANES OF 1916 AND NOTES ON HURRICANES OF 1912-1915.

By RICHARD HANSON WEIGHTMAN.

[Dated: Weather Bureau, Washington, D. C., Feb. 5, 1917.]

The season of tropical storms of the year of 1916 in the West Indies was noteworthy on account of the large number of disturbances reported. In fact in only 2 previous years out of the last 40 were more storms noted—namely, in 1886 and 1887. Besides the nine more important storms noted in 1916 there were several minor disturbances which, although locally severe, were of such short duration that it was not thought advisable to chart them. The season was also remarkable for the number of disturbances of intense character within the Tropics.

Detailed descriptions of the storms that occurred during the hurricane season of 1916 are given in the issues of the MONTHLY WEATHER REVIEW for the respective months and contain all data available at the time the several numbers went to press. Data which have come to hand since the issues above mentioned are presented in this paper and tend to supplement rather than to change the information previously published. Deductions presented regarding origin, track, and intensity that differ from those previously given are based on more complete data. There follows a list of the hurricanes of the past season arranged in chronological order with a few brief remarks accompanying them. An attempt is made to give a rough idea of the intensity of the disturbances noted by the use of the terms slight intensity, moderate intensity, of severe intensity, etc., while an estimate of their extent is indicated by employing expressions such as slight, moderate, large, etc. It must be realized, however, that reports in most cases are widely scattered and that estimates such as indicated above are in a number of cases therefore merely estimates. The paths of the 1916 hurricanes are shown grouped by months on Chart X (XLIV–152) of this issue of the REVIEW.

Remarks concerning the previous history of storms are based on a study of Bulletin "X", Hurricanes of the West Indies" by Oliver L. Fassig.

Appreciation is hereby noted of a collection of reports from a number of the islands of the West Indies forwarded by Mr. Francis Watts, commissioner of agriculture, Barbados, British West Indies, and also of numerous and valuable reports from vessels at sea.

NOTES ON HURRICANES OF 1916.

July 1–10.—The disturbance originated in approximately latitude 16° N., longitude 84° W., attained moderate intensity after passing through the Yucatan Channel, and reached the Gulf coast of the United States immediately west of Mobile, Ala., as a severe storm. The lowest barometer at Mobile was 28.92 inches and the maximum wind velocity (maintained for 5 minutes), 107 miles an hour from the east. Penascola reported a maximum velocity of 104 miles an hour from the southeast. These velocities were records for their respective stations. The velocity at Pensacola was exceeded in the storm of October 18, 1916, a report of which follows.

In a way this storm may be said to have followed an average course for the month, in that it passed to the east Gulf coast after having originated in the western Caribbean Sea.

July 11–15.—This disturbance, as far as reports are available, seems to have originated immediately east of the Bahamas in about latitude 24° 30′ N. It moved northwestward to the South Carolina coast, passing inland over or near Charleston, S. C. The lowest pressure reading at that station was 29.02 inches and the maximum wind velocity 64 miles an hour from the northeast. The U. S. S. *Hector* in latitude 31° 45′ N., longitude 78° 53′ W., reported a barometer reading (aneroid) of 28.37 inches which, upon subsequent comparison of the instrument, is thought to be reasonably accurate. This disturbance was moderately severe in intensity and of small area.

This is the first July storm of record that passed northwestward from the region of the Bahamas and struck the south Atlantic coast.

July 12–22.—The origin of this storm was in about latitude 15° N., longitude 61° W. The center passed northwestward to latitude 29° and thence almost due north, striking the southern New England coast with diminished energy. The lowest pressure reading, 28.94 inches (aneroid), was reported in latitude 27° 30′ N., longitude 73° W., by the S. S. *Ausable* shortly after 1 a. m. of the 19th, with wind force 11–12. This disturbance was of moderate to great intensity and of moderate to large area.

There is only one other storm of record in July that originated in low latitudes so far to the eastward. That storm passed westward south of the islands of the Greater Antilles, while the storm of the present year passed northwestward, north of the Antilles.

August 12–19.—This storm had its origin in approximately latitude 14° N., longitude 56° 30′ W. It passed westward south of the Greater Antilles and through the Yucatan Channel, later striking the Texas coast a little south of Riviera, which is situated about 45 miles southwest by south of Corpus Christi. At Kingsville, about 14 miles north of Riviera, the lowest pressure reported was 28 inches (corrected) on an aneroid barometer, while at Del Rio, at 8 a. m. (75th meridian time) on the 19th, a pressure of 28.72 inches was observed. The highest wind velocity at Corpus Christi was about 90 miles an hour. The storm was severe and moderate to large in extent.

This disturbance followed an average course for the type of August hurricanes that passes through the Yucatan Channel.

August 22.—The disturbance passed south of Tortola (Virgin Islands) and across the island of Porto Rico on a course a little north of west, the lowest pressure reported at San Juan being 29.44 inches at 7 a. m., while the maximum wind velocity was over 90 miles an hour. The origin of this storm is very uncertain and, after crossing the island of Porto Rico, there is little if any trace of it to be found. It was of moderate intensity and extremely small area.

August 28–September 1.—The exact origin of the disturbance is unknown, but was undoubtedly some distance to the east of the island of Dominica. The first trace obtainable is at Roseau, Dominica, over or immediately south of which

city it passed about 7:30 p. m., of the 28th, with a minimum pressure reading at that station of 29.12 inches. It moved thence westward and passed immediately north of the island of Jamaica, with greatly decreased intensity, to a position to the northwest of Swan Island, in which vicinity it lost intensity. It was evidently of small diameter and great intensity while passing over Dominica.

September 4–5.—This disturbance originated east of the northern Bahamas and moved northwest, passing to the coast near and south of Jacksonville, Fla. It was of slight energy and extent.

September 20–23.—The origin of this storm was near Antigua, whence it passed northwestward as far as can be ascertained from a limited number of vessel reports and recurved to the west of the Bermudas. It was of only moderate extent and slight to moderate intensity.

October 4.—This disturbance had its origin northeast of the Bahamas, moved westward and passed inland over northern Florida. It was of small extent and energy.

October 7–12.—The origin of this disturbance is somewhat difficult to determine. Conditions were very unsettled, however, in the neighborhood of the Windward Islands during the 7th and 8th. On the afternoon of the 7th there were some indications of a disturbance near and slightly to the west of Martinique. On the 8th, Roseau, Dominica, experienced a heavy sea, the breakers washing high inland and causing some damage. On the evening of the same date the wind at Basseterre, St. Kitts, veered from northeast to southeast and held in that quarter all day. The sea was heavy and the waves came up over the sea wall. Reports from Tortola, Virgin Islands, indicate that during the morning and early afternoon of the 9th the winds held southeast and were light, but about 4 or 5 p. m., they increased in force. The wind was of greatest violence about 8 or 9 p. m. (100 miles an hour, estimated). After the passage of the storm the winds veered through south and southwest to west. The following readings of the barometer were taken by Mr. W. C. Fishlock, curator at Tortola, Virgin Islands:

October 9: 7 p. m., 29.70; 7:30 p. m., 29.40; 8 p. m., 29.10; 8:30 p. m., 28.90; 8:50 p. m., 28.80; 9:30 p. m., 28.94; 9:50 p. m., 29.10; 10:30 p. m., 29.20; 11 p. m., 29.30; 11:45 p. m., 29.30–29.40 (oscillating); midnight, 29.30–29.40 (oscillating).
October 10: 12:30 a. m., 29.30–29.40; 1 a. m., 29.40; 1:10 a. m., 29.40; 3 a. m., 29.58; 7 a. m., 29.74.

Readings made by Mr. Tanggard on the Island of St. Thomas and published in Lightbourn's Mail Notes, October 12, 1916, follow:

October 9: 7:30 a. m., 29.724; 1 p. m., 29.666; 2:15 p. m., 29.576; 3 p. m., 29.549; 5 p. m., 29.439; 6 p. m., 29.260; 7 p. m., 28.263; 9 p. m., 28.264; midnight, 29.261;
October 10: 6 a. m., 29.637; 8 a. m., 29.700.

The lowest reading at St. Croix, as reported in the Barbados Standard of October 12, was 28.45 inches during the night of the 9th–10th. At St. Thomas and Tortola the winds veered, while at St. Croix they backed. The disturbance evidently passed nearly over and a little to the south of St. Thomas, on a course almost due northwest and later recurved to the northeastward south of the Bermudas, evidenced by a report of hurricane winds encountered by the bark *Bellas* in latitude 27° 40′ N., longitude 62° 20′ W., and by a report from the *Aros Castle* (Br. SS.) in latitude 25° 18′ N., longitude 63° 13′ W. According to this report the *Aros Castle* experienced shifting southwesterly winds of hurricane force, with a barometer reading of 28.38 inches (aneroid) at 4 p. m. of the 11th. From earlier observations by the same vessel it is estimated that the aneroid read between 0.10 and 0.20 inch too low. The storm was of small area and of great intensity.

October 12–18.—The origin of this disturbance is somewhat doubtful, although the first definite indications place it to the south of Jamaica in approximately latitude 16° N., longitude 77° W., on the 12th. It then moved to the westward, passing south of and very close to Swan Island, where a barometric pressure of 28.94 inches was reported during the 14th, with winds of hurricane force. Several reports from vessels enable the storm to be quite closely located on the 16th and 17th and show that the disturbance, after moving a little north of west during the 15th, turned sharply to the northward on the 16th and reached the Gulf coast on the 18th, very close to and immediately west of Pensacola, Fla., where a barometer reading of 28.76 inches was reported. The maximum wind velocity, reported as 114 miles an hour, constitutes a record for the station. The storm was very intense and of moderate area.

This storm was quite remarkable for the month in that it held a westerly course in low latitudes for four days, finally reaching longitude 87° or 88° W., before turning to the northward.

November 12–15.—This disturbance originated in approximately latitude 12° N., longitude 81° W. It moved thence northwestward, recurving over the southeastern portion of the Gulf of Mexico, and advanced rapidly east-northeastward over extreme southern Florida during the 15th in the trough of a disturbance to the northward. This disturbance was evidently of marked intensity in lower latitudes, for according to press reports considerable damage was caused to property along the coast of Spanish Honduras and in Yucatan.

NOTES ON HURRICANES OF 1912–1915.

Chart X (XLIV–121), in the MONTHLY WEATHER REVIEW for September, 1916, shows the tracks of tropical storms for the period, 1912–1915. A few notes, arranged by months, follow regarding these storms.

August 10–17, 1915.—This disturbance originated slightly to the east of the island of Martinique and passed, on a course a little north of west, south of the Greater Antilles, along the northern side of the island of Jamaica. Its course then bore slightly more to the northward, and, after passing nearly over Cape San Antonio, Cuba, it advanced northwestward to the Texas coast immediately south of Galveston. The lowest pressure reading was 28.20 inches at Houston, Tex., up to this time the lowest mercurial barometer reading reported in the United States. (Record was again broken in the September, 1915, storm at New Orleans.) This storm was of hurricane intensity while in the Caribbean Sea, before passing through the Yucatan Channel, as indicated by the destruction of the wireless tower and other equipment at Cape San Antonio. The storm was of great magnitude.

The track of this disturbance was not abnormal for August storms that pass through the Yucatan Channel. In this connection, it is interesting to note that all previous August storms that have passed through the Yucatan Channel have advanced without recurve to the Texas or Mexican coasts, no storm of this character ever having struck the Gulf coast east of Galveston.

August 29–September 9, 1915.—As nearly as can be ascertained, this disturbance had its origin in a proximately latitude 27° N. and longitude 27° W. It moved first on a course slightly north of west, passing to a position northwest of the Bermudas, whence it passed southward to the west of the Islands, then southeastward, then

westward and later northward and northeastward. From the evening of the 2d to the evening of the 4th the pressure at Hamilton ranged between 29.17 and 29.32 inches.

The track of this storm was most unusual, its recurve being blocked and the storm forced southward by the high pressure to the northward. The storm was moderately severe and of moderate area.

September 1–4, 1915.—This disturbance originated in approximately latitude 16° N., longitude 80° W., and after passing north-northwestward over western Cuba, crossed the Gulf coast immediately west of Apalachicola. The lowest pressure recorded at that station was 29.32 inches. A pressure of 29.08 inches, however, was reported by the United States Coast Guard cutter *Miami* off the west coast of extreme southern Florida on the morning of the 3d. The intensity of this storm was moderately severe and its diameter extremely small.

September 22–30, 1915.—This storm had its origin to the west of the Windward Islands in approximately latitude 14° 30′ N., and longitude 63° W. It moved westward, passing south of Jamaica and thence northwest through the Yucatan Channel, crossing the Gulf coast slightly west of New Orleans. The lowest pressure recorded at that station was 28.11 inches, which is probably the lowest reading of a mercurial barometer ever observed in the United States. The report of lowest pressure observed at sea was given by the S. S. *Almirante*, in approximately latitude 15° 50′ N., and longitude 77° 30′ W. The report contained information as follows: "Barometer pumping between 27.50 and 27.60 inches." The barometer was an aneroid with a correction of plus 0.01 inch. This is the lowest authentic reading reported in the West Indies or Caribbean Sea so far as known.

The hurricane was the most intense in history so far as our records show and was of large area. The track was not unusual for a storm of this month that passes from the Caribbean Sea through the Yucatan Channel.

October 11–17, 1912.—This disturbance originated a short distance west of Jamaica in approximately latitude 18° N., longitude 80° W., and, after passing west-northwestward through the Yucatan Channel, struck the Texas coast at a point about equally distant from Corpus Christi and Brownsville. The disturbance was of only moderate intensity and of small to moderate area.

The course of this disturbance was most unusual when compared to other October storms that passed through the Yucatan Channel. Only one previous storm of record followed a track at all similar to the 1912 storm, namely, that of 1887. The storms of 1886, 1887, and 1912 are the only tropical storms in the month of October that have struck the Gulf coast west of Mobile.

SECTION IV.—RIVERS AND FLOODS.

RIVERS AND FLOODS, DECEMBER, 1916.

By ALFRED J. HENRY, Professor in Charge River and Flood Division.

[Dated: Weather Bureau, Jan. 26, 1917.]

The streams in all parts of the country were uniformly at low stages during December, that month being the third successive month without floods of consequence in some part of the country.

Hydrographs for typical points on several principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.

MEAN LAKE LEVELS DURING DECEMBER, 1916.

By UNITED STATES LAKE SURVEY.

[Dated: Detroit, Mich., Jan. 6, 1917.]

The following data are reported in the "Notice to Mariners" of the above date:

Date.	Lakes.			
	Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during December, 1916:	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Above mean sea level at New York	603.16	580.56	571.56	245.37
Above or below—				
Mean stage of November, 1916	−0.34	−0.08	−0.14	−0.28
Mean stage of December, 1915	+0.47	+1.16	+0.19	+0.59
Average stage for December, last 10 years	+0.94	+0.55	−0.11	−0.02
Highest recorded December stage	+0.03	−1.96	−1.97	−2.24
Lowest recorded December stage	+1.96	+1.58	+0.70	+1.94
Average relation of the December level to—				
November level	−0.2	−0.1	−0.1	−0.1
January level	+0.3	+0.2	−0.1	−0.1

SECTION V.—SEISMOLOGY.

THE ALABAMA EARTHQUAKE OF OCTOBER 18, 1916.

By RUY HERBERT FINCH, Assistant.

[Dated: Seismological Investigations, Weather Bureau, Jan. 30, 1917.]

An earthquake occurred on October 18, 1916, a little to the northeast of Birmingham, Ala., that has been reported from eight different States: Alabama, Georgia, Indiana, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee. Undoubtedly it was felt in Florida also, as Geneva on the Alabama-Florida line reported it with an intensity of II, Rossi-Forel.

The occurrence of this earthquake was unnoticed in many places owing to the high winds and heavy rain incident to a hurricane then passing over the east Gulf States. Several persons, in fact, mistook the earthquake disturbance for wind effects. Thus, the observer at Marshallville, Ga., remarked to his wife, "We are having some wind to-day," to which she replied that there was just one strong gust and that it had died down.

The data used in this note, given in some detail on pages 589–590 in the MONTHLY WEATHER REVIEW for October, 1916, were obtained from some 200 card reports rendered by Weather Bureau cooperative observers, United States postmasters, and others. Thanks are specially due to Mr. W. N. Maddox, of Easonville, Ala., who furnished much valuable information.

The influence of the geologic structure on the propagation of the earthquake waves is shown by the fact that the earthquake was felt 340 miles to the north and to the east, 190 miles to the south, and only 130 miles to the west, where the waves encountered the unconsolidated material of the Mississippi Delta. To the northeast along the continuation of the ridge in which the epicenter is situated, the quake was not felt as far as it was to the north and east. (See fig. 1.) An interesting account of the difference in effects of an earthquake on dry hilly land and moist sandy land was furnished by Hon. R. E. Thompson, of Toomsuba, Miss. Mr. Thompson, whose house is located on a damp sandy foundation, felt and could give a good description of the earthquake, while his neighbors whose houses are on higher and drier land did not know that anything unusual had occurred.

Instrumental records of the earthquake were made by the seismographs of the University of Kansas at Lawrence, Kans., Georgetown University, and the Weather Bureau at Washington, D. C.

The highest intensity reported was VII–VIII (Rossi-Forel) at Easonville and Irondale, Ala. The different intensities as reported are shown on the accompanying chart. The isoseismals are, of course, only relatively accurate and are drawn for average values. The inaccuracy of isoseismals based upon a few reports is well illustrated by the fact that Lewisburg, Tenn., reported the quake with an intensity of IV–V, while a small hamlet on a rural free mail delivery route from Lewisburg reported that it was not felt.

The time of the shock as given by a majority of reports was 4:03–4:04 p. m., 90th meridian time. Mr. C. F. von Herrmann, in charge of the Weather Bureau office at Atlanta, Ga., reported two shocks and gave the time very accurately, reporting the first shock at $4^h\ 04^m\ 05^s$ and the second at $4^h\ 05^m\ 25^s$ p. m. But as Atlanta is about 130 miles from the epicenter it may be that these two shocks were only different phases of the same quake. The average time of the occurrence at the epicenter, as determined from the seismograph records of the University of Kansas, Georgetown University, and the Weather Bureau at Washington by means of the P-O table of Dr. Klotz, is $4^h\ 03^m\ 14^s$ p. m.

As is usual, the main shock of October 18 was followed by several weaker ones. At 10:54 p. m. October 18 a shock was felt over most of the territory bounded by the VII isoseismal. A few people felt shocks at about 9 p. m., October 22, and on the morning of October 28. Birmingham was shaken by a light tremor at 6:15 a. m. November 4, but there is some doubt as to whether this was seismic or due to a mine explosion.

The Geological Survey detailed a trained geologist, Mr. Oliver B. Hopkins, to make a study of the epicenter region, and his interesting report follows.

NOTES RELATING TO THE EARTHQUAKE OF OCTOBER 18, 1916, IN NORTH-CENTRAL ALABAMA.[1]

By OLIVER B. HOPKINS, Associate Geologist.

[Dated: U. S. Geological Survey, Washington, D. C., Jan. 8, 1917.]

Observations.

Time.—According to Mr. C. J. Yow, train dispatcher of the Southern Railway at Pell City, Ala., the most intense shock occurred at 4:03 p. m. (90th meridian time), October 18, and smaller, but distinct, shocks at 8:53 p. m. and 9:11 p. m. on October 22. Other shocks are reported by a number of people as having occurred at about 11 p. m. October 18 and about 6 a. m. October 28. The first shock at 4:03 p. m. on October 18 is the only one which was sufficiently severe to be generally felt from Birmingham eastward beyond Pell City.

Duration.—The duration of the first shock has been variously estimated from less than one-half minute to more than a minute. No close estimate of the actual time during which the movement could be felt can be given because few people realized that any disturbance was taking place until it had reached its maximum intensity. An observer near Easonville was certain from his action during the shock that it could be distinctly felt for more than a minute; on the other hand another observer at Irondale stated that it could be felt probably less than one-half minute, since he rushed out of doors as soon as he was conscious of the shaking and when he got outside the shaking had ceased.

The subsequent shocks were less severe and were experienced by few people.

Direction of vibration.—The examination of a number of fallen objects, principally chimneys, near Easonville, Pell City, and Irondale, suggests that the direction of

[1] Published by permission of the Director of the U. S. Geological Survey, as conveyed in his letter of Jan. 8, 1917.

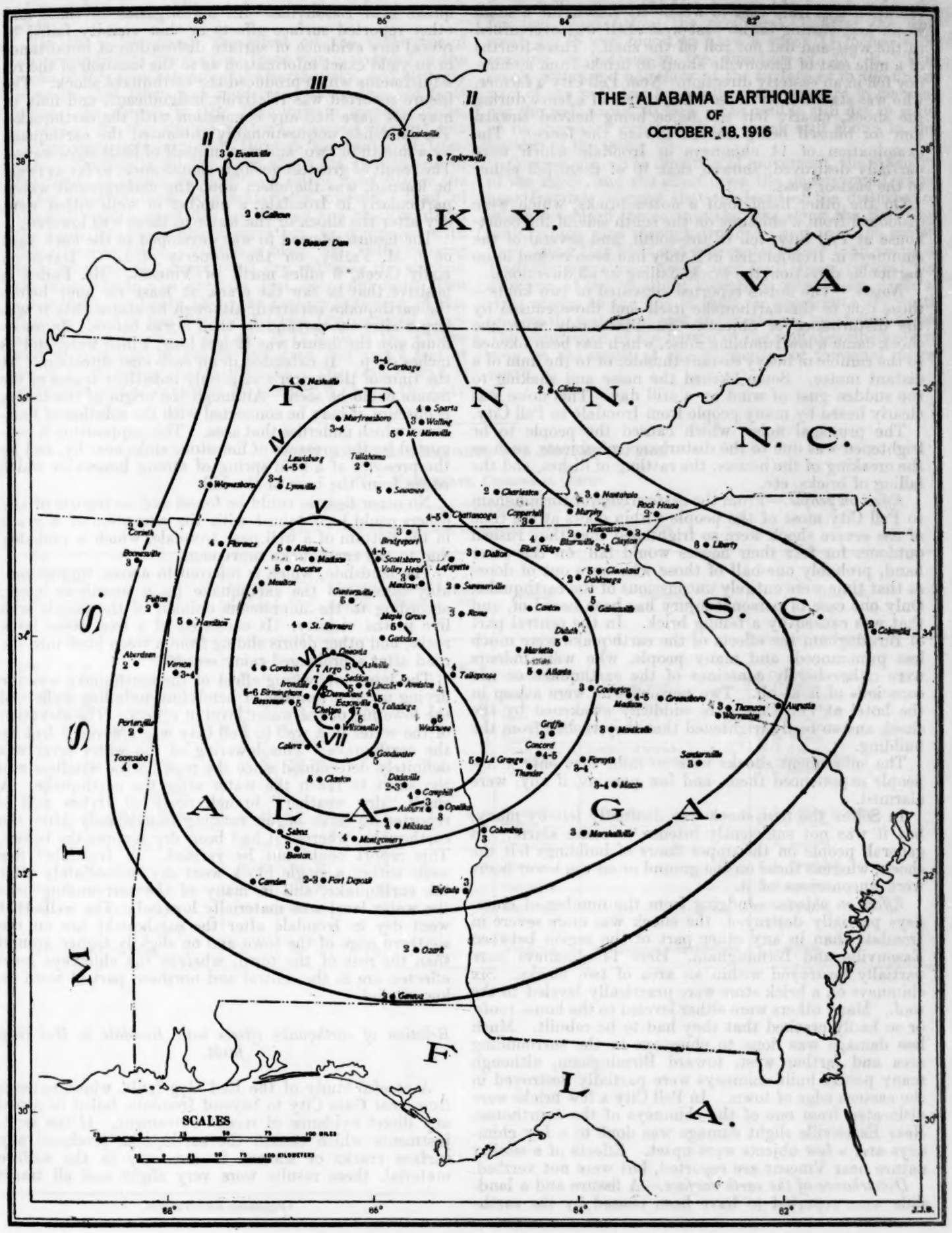

FIG. 1.—Isoseismals of the Alabama earthquake of October 18, 1916.

vibration was from east to west. At Easonville a small water keg, resting on an east-west shelf was overturned to the west and did not roll off the shelf. Three-fourths of a mile east of Easonville about 30 bricks from a chimney fell in an easterly direction. Near Pell City a farmer, who was standing on the southwest side of a fence during the shock, clearly felt the fence being heaved toward him (or himself being heaved toward the fence). The examination of 14 chimneys in Irondale which were partially destroyed, showed that 10 of them fell either to the east or west.

On the other hand, half a dozen bricks, which were dislodged from a chimney on the south side of the courthouse at Pell City, fell to the south, and several of the chimneys in Irondale fell as if they had been rocked in no particular direction, the bricks falling in all directions.

Noises.—The noises reported consisted of two kinds—those due to the earthquake itself and those caused by the disturbance of objects. Simultaneously with the shock came a low rumbling noise, which has been likened to the rumble of heavy distant thunder or to the hum of a distant motor. Some likened the noise and shaking to the sudden gust of wind on a still day. This noise was clearly heard by many people from Irondale to Pell City.

The principal noise, which caused the people to be frightened was due to the disturbance of objects, such as the creaking of the houses, the rattling of dishes, and the falling of bricks, etc.

Effect on people.—From the eastern edge of Birmingham to Pell City most of the people within doors at the time of the severe shock were so frightened that they rushed outdoors for fear their houses would fall; on the other hand, probably one-half of those who were out of doors at that time were entirely unconscious of the earthquake. Only one case of personal injury has been heard of, and that was caused by a falling brick. In the central part of Birmingham the effects of the earthquake were much less pronounced, and many people, who were indoors were either barely conscious of the earthquake or not conscious of it at all. Two persons who were asleep in the hotel at Pell City were suddenly awakened by the shock and so badly frightened that they rushed from the building.

The subsequent shocks were so mild that only a few people experienced them, and few persons, if any, were alarmed.

In Selma the first shock was distinctly felt by many, but it was not sufficiently intense to cause alarm. In general, people on the upper floors of buildings felt the shock, whereas those on the ground or on the lower floors were unconscious of it.

Effect on objects.—Judging from the number of chimneys partially destroyed, the shock was more severe in Irondale than in any other part of the region between Easonville and Birmingham. Here 14 chimneys were partially destroyed within an area of two blocks. Six chimneys on a brick store were practically leveled to the roof. Many others were either leveled to the house roofs, or so badly cracked that they had to be rebuilt. Much less damage was done to chimneys in the surrounding area and farther west, toward Birmingham, although many poorly built chimneys were partially destroyed in the eastern edge of town. In Pell City a few bricks were dislocated from one of the chimneys of the courthouse. Near Easonville slight damage was done to a few chimneys and a few objects were upset. Effects of a similar nature near Vincent are reported, but were not verified.

Disturbance of the earth surface.—A fissure and a landslide were reported to have been caused by the earthquake near Easonville. An investigation of these and other reported surface effects in that vicinity failed to reveal any evidence of surface dislocation of importance or to yield exact information as to the location of the readjustments which produced the earthquake shock. The fissure reported was relatively insignificant, and may or may not have had any connection with the earthquake. The landslide unquestionably antedated the earthquake by a month or two, and was in itself of little significance. The result of greatest geologic significance, so far as could be learned, was the effect upon the underground water, particularly in Irondale; a number of wells either went dry after the shock or the water in them was lowered.

The fissure referred to was developed in the back yard of J. M. Farley, on the property of L. C. Davis on Kelly Creek, 6 miles north of Vincent. Mr. Farley is positive that he saw the crack at least an hour before the earthquake occurred, although he states that it was larger after the earthquake than it was before. In maximum size the fissure was 12 feet long, 1 inch wide, and 18 inches deep. It extended in an east-west direction. At the time of the writer's visit only indistinct traces of the fissure could be seen. Although the origin of the fissure is obscure, it may be connected with the solution of limestone which underlies that area. This supposition is supported by the presence of limestone sinks near by, and by the presence of a bold spring of strong limewater which issues from the base of the hill.

No other fissures could be found and no reports of any others could be obtained with the exception of a crack in the bottom of a well near Irondale, which is probably due to the earthquake movement.

The landslide, which is referred to above, unquestionably antedated the earthquake by a month or more, according to the unanimous opinion of the people who live in the vicinity. It consisted of a tree, some large rocks, and other débris sliding from a steep bluff into the road after a prolonged rainy season.

The most interesting effect of the earthquake was the drying up of a number of heretofore unfailing wells and the lowering of the water level in others. The elevation of the water in a well in Pell City was lowered 2 feet by the earthquake. This lowering of the water level was definitely determined since the rope on the windlass was too short to reach the water after the earthquake. A small "dry weather" branch north of Dykes mill is reported to have begun running immediately after the earthquake, whereas it had been dry for months before. This report could not be verified. In Irondale [3] five wells within a single block went dry immediately after the earthquake, and in many of the surrounding ones the water level was materially lowered. The wells that went dry in Irondale after the earthquake are on the southern edge of the town and on slightly higher ground than the rest of the town, whereas the chimneys most affected are in the central and northern part of town on low ground.

Relation of earthquake effects near Irondale to Red Gap fault.

A careful study of the Red Gap fault, which extends from near Gate City to beyond Irondale, failed to reveal any direct evidence of recent movement. If the readjustments which caused the earthquake produced any surface cracks or showed in any way in the surface material, these results were very slight and all traces

[3] Population was 572 in 1910.

of them had been obliterated at the time of the writer's visit.

On the other hand, the effect on the underground water conditions proves that there was movement in the rocks of this area attending the earthquake, and strongly suggests that there was movement along this old fault plane. As shown in the Birmingham geologic folio, published by the United States Geological Survey, this fault passes approximately through the center of Irondale. Practically all the wells along the eastern end of the fault, as shown on that map, either went dry or the water level in them was materially lowered. Most of the wells which went dry are located one block south of the fault line on a slight elevation, as compared with the others in town. Within a block five wells, ranging from 35 to 40 feet deep, went dry, whereas the sixth in the row which was only 14 feet deep did not. Two other wells, probably along the eastern extension of tnis fault or near it went dry. One is a few hundred yards east of the center SE. ¼ sec. 29, T. 17 S., R. 1 W., 4 miles east of Irondale; it was 28 feet deep and had 7 feet of water in it before the earthquake. The second well is 200 yards east of center of W. line of SW. ¼ sec. 19, T. 17 S., R. 1 W.; it was 47½ feet deep and had produced water for two years before the earthquake. After the well went dry it was found to have a crack 1½ inches wide crossing its bottom in the direction N. 33° E. This crack, which did not show at the surface or in the upper part of the well, has been followed downward in deepening the well about 30 feet. The well is still dry in spite of its increased depth and the crack still shows in the bottom of the well.

Conclusions.—The direction of movement, the intensity of the shock, and the effect upon the underground water near Irondale, suggest that the locus of the disturbance which produced the earthquake was along the Red Gap fault, which runs through Irondale; and that the movement along this fault was horizontal rather than vertical. Had the movement along this fault been vertical the direction of the resultant vibrations would have been at right angles to the line of fault, or approximately north and south, instead of east and west as it was found to be. The occurrence of the fissure in the well described above may be the result of this horizontal or torsional movement.

SEISMOLOGICAL REPORTS FOR DECEMBER, 1916.

W. J. HUMPHREYS, Professor in Charge.

[Dated: Weather Bureau, Washington, D. C., Dec. 1, 1916.]

TABLE 1.—*Noninstrumental earthquake reports, December, 1916.*

Day.	Approximate time, Greenwich Civil.	Station.	Approximate latitude.	Approximate longitude.	Intensity Rossi-Forel.	Number of shocks.	Duration.	Sounds.	Remarks.	Observer.
		ARIZONA.								
1916.	*H. m.*		° ′	° ′			*M. s.*			
Dec. 12	12 45	Fort Apache	33 47	109 55	5	1	0 3	Rumbling		J. C. F. Tillson, jr.
	12 45	Henry's Camp	33 41	109 48	5	1	7		Awakened people	G. J. Henry.
	12 45	Holbrook	34 54	110 08	5	1	15	None		Thorwald Larson.
	12 45	Lakeside	34 06	109 59	4–5	1	60	None	Dishes rattled	T. H. Owens.
	12 45	Pinedale	34 19	110 15	5	2	6	None		E. Thomas, jr.
	12 45	Piato	35 05	109 38	5	1	15	Rumbling	Doors slammed	Mrs. Celia Henning.
	12 45	Shumway	34 26	110 04	5	1	3	Rumbling		F. R. Wigely.
	12 45	Snowflake	34 33	110 04	4	1		None	Awakened people	W. J. Flake.
	12 45	St. Michaels	35 38	109 05	5	1		Rumbling	Some plaster cracked	St. Michaels School.
	12 45	Thatcher	32 50	109 47	3	1	20	None		T. C. Snow.
		CALIFORNIA.								
1	22 50	San Luis Obispo	35 18	120 39	7	1	0 8	Rumbling	Plaster fell	U. S. Weather Bureau.
	22 50	Santa Maria	34 58	120 28	3	1		None		Walter White.
7	18 55	Calexico	32 40	115 28	5	1		Rumbling		F. R. Spencer.
7	20 30	Bishop	37 21	118 22	3	2	8	None		E. L. Herzinger.
7	20 45	Calexico	32 40	115 28	5	1		Rumbling		F. R. Spencer.
18	19 50	Calexico	32 40	115 28	2	1		Rumbling		F. R. Spencer.
		KENTUCKY.								
19	5 42	Hickman	36 35	89 12	5–6	2		Rumbling	Bricks shaken from chimneys	J. C. Sexton.

TABLE 2.—*Instrumental seismological reports, December, 1916.*

[Time used: Mean Greenwich, midnight to midnight. Nomenclature: International.]

[For significance of symbols see this REVIEW, January, 1916, p. 39.]

Alaska. *Sitka. Magnetic Observatory.* U. S. Coast and Geodetic Survey. J. W. Green.

Lat., 57° 03′ 00″ N.; long., 135° 20′ 06″ W. Elevation, 15.2 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants:

	V	T_0
E	10	16.6
N	10	15.4

(No earthquake recorded during December, 1916.)

Arizona. *Tucson. Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. P. Ulrich.

Lat., 32° 14′ 48″ N.; long., 110° 50′ 06″ W. Elevation, 769.6 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants:

	V	T_0
E	10	13.9
N	10	19.1

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1916. Dec. 12	.....	e.....	*H. m. s.* 12-44-45	*Sec.*	*μ*	*μ*	*Km.*	Earthquake in eastern Arizona.
		M_N....	12-45-10	4	.....	.....	.....	
		F.....	12-49-00	.....	.....	.....	.....	

California. *Berkeley. University of California.*

Lat., 37° 52′ 16″ N., long., 122° 15′ 37″ W. Elevation, 85.4 meters.

(*See* Bulletin of the Seismographic Stations, University of California.)

California. *Mount Hamilton. Lick Observatory.*

Lat., 37° 20′ 24″ N.; long., 121° 38′ 34″ W. Elevation, 1,281.7 meters.

(*See* Bulletin of the Seismographic Stations, University of California.)

California. *Point Loma. Raja Yoga Academy.* F. J. Dick.

Lat., 32° 43′ 03″ N.; long., 117° 15′ 10″ W. Elevation, 91.4 meters.

Instrument: Two-component, C. D. West seismoscope.

1916.			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Dec. 2	.....	.....	.....	.....	*200	*200	.....	Tremors during 24 hours preceding 15h on dates given.
3	.....	.....	.....	.....	*450	*450	.....	
4	.....	.....	.....	.....	*300	*400	.....	
5	.....	.....	.....	.....	*100	*100	.....	
9	.....	.....	.....	.....	*100	*200	.....	
11	.....	.....	.....	.....	*200	*200	.....	
14	.....	.....	.....	.....	*200	*200	.....	
16	.....	.....	.....	.....	*200	*300	.....	
22	.....	.....	.....	.....	*100	*100	.....	
24	.....	.....	.....	.....	*50	*100	.....	
28	.....	.....	.....	.....	*200	*400	.....	

*Amplitudes on instrument.

California. *Santa Clara. University of Santa Clara.* J. S. Ricard, S. J.

Lat., 37° 26′ 36″ N.; long., 121° 57′ 03″ W. Elevation, 27.43 meters.

(See record of the Seismographic Station, University of Santa Clara.)

Colorado. *Denver. Sacred Heart College.* Earthquake Station. A. W. Forstall, S. J.

Lat., 39° 40′ 36″ N.; long., 104° 56′ 54″ W. Elevation, 1,655 meters.

Instrument: Wiechert 80 kg., astatic, horizontal pendulum.

Instrumental constants .....

(No earthquakes observed during December, 1916.)

District of Columbia. *Washington. U. S. Weather Bureau.*

Lat., 38°, 54′ 12″ N.; long., 77° 03′ 03″ W. Elevation, 21 meters.

Instrument: Marvin (vertical pendulum), undamped. Mechanical registration.

Instrumental constants..

V	T_0
110	6.4

1916.			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Dec. 14	.....	P.....	17 03 40	.....	.....	.....	7,645	
		S.....	17 12 42	.....	.....	.....	.....	
		eL_M?..	17 26 00	.....	.....	.....	.....	
		L.....	17 33 30	16	.....	.....	.....	
		F.....	18 00 00	.....	.....	.....	.....	
23	.....	P.....	9 34 42	.....	.....	.....	6,900	
		S.....	9 43 06	.....	.....	.....	.....	
		L.....	9 54 40	.....	.....	.....	.....	
		L.....	10 05 01	20	.....	.....	.....	
		F.....	10 20 ..	.....	.....	.....	.....	F in microseisms.

District of Columbia. *Washington. Georgetown University.* F. L. Tondorf, S. J.

Lat., 38° 54′ 25″ N.; long., 77° 04′ 24″ W. Elevation, 42.4 meters. Subsoil: decayed diorite.

Instruments: Wiechert 200 kg., astatic, horizontal pendulums; 80 kg., vertical.

Astatic pendulums after Mainka, 130 kg.

Instrumental constants:

	V	T_0	ε
E	165	5.4	0
N	143	5.2	0
Z	*80*	*3.0*	*0*

1916.			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Dec. 14	.....	eP.....	17 03 41	.....	.....	.....	.....	Heavy microseisms due to wind. No distinct maximum
		eS_N...	17 12 45	.....	.....	.....	.....	
		eS_E...	17 12 47	.....	.....	.....	.....	
		eL_E...	17 23 39	.....	.....	.....	.....	
		eL_N...	17 23 44	.....	.....	.....	.....	
		L_E....	17 33 30	36	.....	.....	.....	
		L_N....	17 33 44	36	.....	.....	.....	
		F.....	18 03 00	.....	.....	.....	.....	
23	.....	eP_N...	9 34 40	.....	.....	.....	.....	Heavy wind markings. No distinct maximum. F lost in wind markings.
		eP_E...	9 34 52	.....	.....	.....	.....	
		iS_E...	9 43 05	.....	.....	.....	.....	
		S_N....	9 43 08	.....	.....	.....	.....	
		eL_N...	9 53 25	.....	.....	.....	.....	
		eL_E...	9 53 27	.....	.....	.....	.....	

TABLE 2.—*Instrumental seismological reports, December, 1916*—Continued.

Hawaii. *Honolulu. Magnetic Observatory.* U. S. Coast and Geodetic Survey. Frank Neumann.

Lat., 21° 19′ 12″ N.; long., 158° 03′ 48″ W. Elevation, 15.2 meters.

Instrument: Milne seismograph of the Seismological Committee of the British Association.

	T_0
Instrument constant..	18.5

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1916.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Dec 2	.....	L.....	12 22 54	19	.....	.....	.....	
		M.....	12 40 54	.....	*200	.....	.....	
		F.....	13 21 00	.....	.....	.....	.....	
2	.....	L.....	23 10 00	20	.....	.....	.....	
		M.....	23 15 00	.....	*100	.....	.....	
		F.....	23 28 00	.....	.....	.....	.....	
5	.....	L.....	15 52 42	18	.....	.....	.....	Merely a broadening of the line.
		M.....	15 54 12	.....	.....	.....	.....	
		F.....	15 58 48	.....	.....	.....	.....	
13	.....	L.....	22 03 48	18	.....	.....	.....	Probably air tremors.
		M.....	22 06 00	.....	*100	.....	.....	
		F.....	22 08 42	.....	.....	.....	.....	
14	.....	e.....	17 08 00	20	.....	.....	.....	
		M.....	17 17 00	.....	*1000	.....	.....	
		C.....	17 19 54	.....	.....	.....	.....	
20	.....	P.....	19 15 42	.....	.....	.....	.....	
		L.....	19 19 30	17	.....	.....	.....	
		M.....	19 22 00	.....	*100	.....	.....	
		C.....	19 26 00	.....	.....	.....	.....	
		F.....	19 28 48	.....	.....	.....	.....	
21	.....	L.....	14 42 12	20	.....	.....	.....	
		M.....	14 46 30	.....	*400	.....	.....	
		C.....	14 49 00	.....	.....	.....	.....	
		F.....	14 59 18	.....	.....	.....	.....	
22	.....	L.....	16 35 06	21	.....	.....	.....	
		M.....	16 39 30	.....	*100	.....	.....	
		C.....	16 48 12	.....	.....	.....	.....	
23	.....	P.....	9 48 24	.....	.....	.....	.....	
		S.....	9 56 06	.....	.....	.....	.....	
		L.....	10 05 24	20	.....	.....	.....	
		M.....	10 14 24	.....	*2200	.....	.....	
		C.....	10 21 00	.....	.....	.....	.....	
		F.....	11 26 00	.....	.....	.....	.....	
26	.....	P.....	20 30 42	.....	.....	.....	.....	
		L.....	20 42 54	23	.....	.....	.....	
		M.....	20 48 00	.....	*1500	.....	.....	
		C.....	20 50 48	.....	.....	.....	.....	
		F.....	21 34 54	.....	.....	.....	.....	
27	.....	P.....	21 58 42	.....	.....	.....	.....	
		L.....	22 07 12	22	.....	.....	.....	
		M.....	22 15 18	.....	*700	.....	.....	
		C.....	22 23 30	.....	.....	.....	.....	
		F.....	22 46 00	.....	.....	.....	.....	

* Trace amplitude.

Kansas. *Lawrence. University of Kansas.* Department of Physics and Astronomy. F. E. Kester.

Lat., 38° 57′ 30″ N.; long., 95° 14′ 58″ W. Elevation, 301.1 meters.

Instrument: Wiechert.

		V	T_0	ε
Instrumental constants...	E	177	3.4	4
	N	205	3.4	4

(Report for December, 1916, not received.)

Maryland. *Cheltenham. Magnetic Observatory.* U. S. Coast and Geodetic Survey. George Hartnell.

Lat., 38° 44′ 00″ N.; long., 76° 50′ 30″ W. Elevation, 71.6 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

		V	T_0
Instrumental constants..	E	10	32
	N	10	27

(No earthquake recorded during December, 1916.)

Massachusetts. *Cambridge. Harvard University Seismographic Station.* J. B. Woodworth.

Lat., 42° 22′ 36″ N.; long., 71° 06′ 59″ W. Elevation, 5.4 meters. Foundation, glacial sand over clay.

Instruments: Two Bosch-Omori 100 kg. horizontal pendulums (mechanical registration).

		V	T_0	ε:1
Instrumental constants..	E	80	23	0
	N	50	25	4:1

(The records from Harvard University are several months behind and will appear in "Table 3.—Late reports," as rapidly as they are measured.)

Missouri. *Saint Louis. St. Louis University.* Geophysical Observatory. J. B. Goesse, S. J.

Lat., 38° 38′ 15″ N.; long., 90° 13′ 58″ W. Elevation, 160.4 meters. Foundation: 12 feet of tough clay over limestone of Mississippi system, about 300 feet thick.

Instruments: Wiechert 80 kg. astatic, horizontal pendulum.

	V	T_0	ε:1
Instrumental constants..	80	7	5:1

(Report for December, 1916, not received.)

New York. *Buffalo. Canisius College.* John A. Curtin, S. J.

Lat., 42° 53′ 02″ N.; long., 78° 52′ 40″ W. Elevation, 190.5 meters.

Instrument: Wiechert 80 kg. horizontal.

	V	T_0	ε:1
Instrumental constants..	80	7	5:1

(Report for December, 1916, not received.)

New York. *Fordham. Fordham University.* W. C. Repetti, S. J.

Lat., 40° 51′ 47″ N.; long., 73° 53′ 08″ W. Elevation, 23.9 meters.

Instrument: Weichert, 80 kg.

		V	T_0	ε
Instrumental constants..	E	72	7.1	1.5:1
	N	72	6.8	3.8:1

(Report for December, 1916, not received.)

New York. *Ithaca. Cornell University.* Heinrich Ries.

Lat., 42° 26′ 58″ N.; long., 76° 29′ 09″ W. Elevation, 242.6 meters.

Instruments: Two Bosch-Omori, 25 kgm., horizontal pendulums (mechanical registration).

		V	T_0	ε
Instrumental constants..	E	13	22	4:1
	N	14	25	4:1

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1916.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Dec. 24	.....	eL_E...	17 27 40	19	.....	.....	.....	Microseisms present.
		eL_N...	17 30 32	25	.....	.....	.....	
		F_E....	17 43 ..	.....	.....	.....	.....	
		F_N....	17 45 ..	.....	.....	.....	.....	

Panama Canal Zone. *Balboa Heights.* Isthmian Canal Commission.

Lat., 8° 57′ 39″ N.; long., 79° 33′ 29″ W. Elevation, 27.6 meters.

Instruments: Two Bosch-Omori, 100 kg.

	V	T_0
Instrumental constants..	10	20.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1916.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Dec. 10	.....	P_E....	3 45 46	.....	.....	.....	170	Direction ? Phases indistinct on N-S, maximum amplitude 10μ.
		L_E....	3 46 04	.....	.....	.....	.....	
		M_E....	3 46 10	.....	70	.....	.....	
		F_E....	3 46 38	.....	.....	.....	.....	
19	.....	P.....	3 53 40	.....	.....	.....	113	Direction?
		L.....	3 53 50	.....	.....	.....	.....	
		M.....	3 53 50	.....	100	120	.....	
		F_E....	3 54 45	.....	.....	.....	.....	
		F_N....	3 55 00	.....	.....	.....	.....	

TABLE 2.—*Instrumental seismological reports, December, 1916*—Concld.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
Porto Rico. *Vieques. Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. L. Adams.								
Lat., 18° 09′ N.; long., 65° 27′ W. Elevation, 19.8 meters.								
Instruments: Two Bosch-Omori.								
Instrumental constants..					V	T_0		
					E 10	18.0		
					N 10	19.5		
1916.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Dec. 23	.....	ePN...	9 32 06	3	.....	.....	.....	
		ePE...	9 32 30	3	.....	.....	.....	
		S.....	9 38 09	4	.....	.....	.....	
		eLE...	9 43 00	14	.....	.....	.....	No long waves apparent on E–W.
		ME...	9 55 00	14	.....	120	.....	
		CE...	10 00 00	.....	.....	.....	.....	
		F.....	10 25 00	.....	.....	.....	.....	
Vermont. *Northfield. U. S. Weather Bureau.* Wm. A. Shaw.								
Lat., 44° 10′ N.; long., 72° 41′ W. Elevation, 256 meters.								
Instruments: Two Bosch-Omori, mechanical registration.								
Instrumental constants..					V	T_0		
					E 10	15		
					N 10	16		
1916.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Dec. 14	.....	L.....	17 35 00	.....	.....	.....	.....	Very feeble record. Phases indiscernible.
			17 40 00					
Canada. *Ottawa. Dominion Astronomical Observatory.* Earthquake Station. Otto Klotz.								
Lat., 45° 23′ 38″ N.; long., 75° 42′ 57″ W. Elevation, 83 meters.								
Instruments: Two Bosch photographic horizontal pendulums, one Spindler & Hoyer 80 kg. vertical seismograph.								
Instrumental constants:					V	T_0		
					120	26		
1916.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Dec. 14	.....	*O*.....	16 52 05	.....	.....	.....	7,770	Strong microseisms mask much on N–S.
		P_E...	17 03 14	.....	.....	.....	.....	
		S_E...	17 12 22	.....	.....	.....	.....	
		eL? ...	17 25 ..	.....	.....	.....	.....	
		L.....	17 28 ..	20–18	.....	.....	.....	
		L.....	17 33 ..	19–18	.....	.....	.....	
		L.....	17 36 ..	16–15	.....	.....	.....	
		F.....	17 50 ..	.....	.....	.....	.....	
23	.....	S_E?...	9 44 14	.....	.....	.....	10,000?	Strong microseisms prevail.
		iS_E...	9 44 24	.....	.....	.....	.....	
		eL_N...	10 04 24	20	.....	.....	.....	
		L_N....	10 10 ..	18	.....	.....	.....	F masked by microseisms.

O—time at origin.

Canada. *Toronto. Dominion Meteorological Service.*

Lat., 43° 40′ 01″ N.; long., 79° 23′ 54″ W. Elevation, 113.7 meters. Subsoil: Sand and clay.

Instrument: Milne horizontal pendulum, North. In the meridian.

Instrumental constant.. T_0 18. Pillar deviation, 1 mm., swing of boom=0.50″.

(Report for December, 1916, not received.)

Canada. *Victoria, B. C. Dominion Meteorological Service.*

Lat., 48° 24′ N.; long., 123° 19′ W. Elevation, 67.7 meters. Subsoil: Rock.

Instrument: Wiechert, vertical: Milne horizontal pendulum, North. In the meridian.

Instrumental constant.. T_0 18. Pillar deviation, 1 mm., swing of boom=0.54″.

(Report for December, 1916, not received.)

TABLE 3.—*Late seismological reports.* (*Instrumental.*)

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
Hawaii. *Honolulu. Magnetic Observatory.* U. S. Coast and Geodetic Survey. Frank Neumann.								
Lat., 21° 19′ 12″ N.; long., 158° 03′ 48″ W. Elevation, 15.2 meters.								
Instruments: Milne seismograph of the Seismological Committee of the British Association.								
Instrumental constant..						T_0 18.5		
1916.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
Nov. 3	.....	L.....	22 17 30	21	.....	.....	.....	
		M.....	22 21 12	.....	*300	.....	.....	
		F.....	22 29 36	.....	.....	.....	.....	
10	.....	L.....	9 29 12	.....	.....	.....	.....	
		M.....	9 30 00	.....	.....	.....	.....	
		C.....	9 37 00	.....	.....	.....	.....	
11	.....	P.....	13 34 00	.....	.....	.....	.....	Some doubt as to motion previous to 13h 40m.
		S.....	13 39 42	.....	.....	.....	.....	
		L.....	13 43 48	19	.....	.....	.....	
		M.....	13 47 48	.....	*400	.....	.....	
		C.....	13 51 30	.....	.....	.....	.....	
		F.....	14 31 00	.....	.....	.....	.....	
11	.....	P.....	15 20 54	.....	.....	.....	.....	
		S.....	15 26 00	.....	.....	.....	.....	
		L.....	15 31 00	19	.....	.....	.....	
		M.....	15 35 00	.....	*400	.....	.....	
		C.....	15 47 00	.....	.....	.....	.....	
		F.....	16 32 00	.....	.....	.....	.....	
13	.....	L.....	7 06 42	.....	.....	.....	.....	
		M.....	7 08 30	.....	.....	.....	.....	
		C.....	7 17 00	.....	.....	.....	.....	
13	.....	e.....	11 55 00	.....	.....	.....	.....	Phases uncertain.
		L.....	12 08 12	19	.....	.....	.....	
		M.....	12 11 00	.....	*200	.....	.....	
		F.....	12 50 00	.....	.....	.....	.....	
14	.....	P.....	23 01 00	.....	.....	.....	.....	
		L.....	23 08 12	19	.....	.....	.....	
		M.....	23 14 48	.....	*400	.....	.....	
		C.....	23 21 42	.....	.....	.....	.....	
		F.....	23 33 ..	.....	.....	.....	.....	
18	.....	P.....	11 50 00	.....	.....	.....	.....	Phases not distinct.
		S.....	11 53 48	.....	.....	.....	.....	
		L.....	12 00 00	19	.....	.....	.....	
		M.....	12 17 12	.....	*300	.....	.....	
		C.....	12 22 00	.....	.....	.....	.....	
		F.....	12 28 30	.....	.....	.....	.....	
20	.....	P.....	22 48 42	.....	.....	.....	.....	
		L.....	22 57 00	19	.....	.....	.....	
		M.....	23 01 00	.....	*300	.....	.....	
		C.....	23 04 00	.....	.....	.....	.....	
		F.....	23 11 00	.....	.....	.....	.....	
21	.....	L.....	3 06 54	.....	.....	.....	.....	Merely a broadening of the line.
		C.....	3 15 00	.....	.....	.....	.....	
21	.....	eP.....	6 36 12	.....	.....	.....	.....	
		S.....	6 44 00	.....	.....	.....	.....	
		eL.....	6 53 54	20	.....	.....	.....	
		M.....	6 57 12	.....	*1200	.....	.....	
		C.....	7 05 00	.....	.....	.....	.....	
		F.....	8 35 00	.....	.....	.....	.....	
24	.....	P.....	2 59 36	.....	.....	.....	.....	
		L.....	3 08 54	18	.....	.....	.....	
		M.....	3 11 42	.....	*200	.....	.....	
		C.....	3 15 00	.....	.....	.....	.....	
		F.....	3 18 00	.....	.....	.....	.....	
24	.....	P.....	4 19 54	.....	.....	.....	.....	
		L.....	4 33 00	19	.....	.....	.....	
		M.....	4 45 48	.....	*200	.....	.....	
		F.....	4 51 00	.....	.....	.....	.....	
24	.....	L.....	13 22 00	19	.....	.....	.....	Phases doubtful on account of irregular motion of paper.
		M.....	13 28 36	.....	*100	.....	.....	
		C.....	13 32 12	.....	.....	.....	.....	
24	.....	L.....	22 20 24	.....	.....	.....	.....	Merely a broadening of the line.
		C.....	22 41 00	.....	.....	.....	.....	
27	.....	e.....	6 53 00	19	.....	.....	.....	
		M.....	6 54 12	.....	*300	.....	.....	
		C.....	6 57 30	.....	.....	.....	.....	
		F.....	7 11 00	.....	.....	.....	.....	
30	.....	e.....	3 58 30	.....	.....	.....	.....	
		L.....	4 04 18	19	.....	.....	.....	
		M.....	4 10 12	.....	*300	.....	.....	
		C.....	4 14 00	.....	.....	.....	.....	
		F.....	4 45 00	.....	.....	.....	.....	

* Trace amplitude.

TABLE 3.—*Late seismological reports.* (*Instrumental*)—Concluded.

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
Massachusetts. *Cambridge. Harvard University Seismographic Station.*								
[J. B. Woodworth temporarily absent. Records interpreted and measured by the U. S. Weather Bureau.]								
Lat., 42° 22′ 36″ N.; long., 71° 06′ 59″ W. Elevation, 5.4 meters. Foundation: Glacial sand over clay.								
Instruments: Two Bosch-Omori 100 kg. horizontal pendulums (mechanical registration).								
Instrumental constants..			V: E 80, N 50	T_0: E 23, N 25	ε: E 0, N 4:1			
1916.			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
June 2	.....	P_E	14 05 40	.....	.....	.....	3,190	
		PR_E	14 06 36	.....	.....	.....	.....	
		S	14 10 37	.....	.....	.....	.....	
		L	14 14 47	.....	.....	.....	.....	
		L	14 20 22	18	.....	.....	.....	
		F	14 50 ..	.....	.....	.....	.....	F in microseisms.
3	.....	eL_E	6 14 30	.....	.....	.....	.....	Very feeble record.
		F	6 22 00	.....	.....	.....	.....	
15	.....	e_E	11 39 53	.....	.....	.....	.....	Sheet changed at 13h 18m before end of quake.
		L_E	12 45 00	20	.....	.....	.....	
19	.....	P_E?	1 24 53	.....	.....	.....	2,900?	
		PR_E?	1 26 48	.....	.....	.....	.....	
		S_E	1 29 33	.....	.....	.....	.....	
		L_E?	1 34 45	.....	.....	.....	.....	
		L_E	1 42 00	20	.....	.....	.....	
		F	2 10 00	.....	.....	.....	.....	
20	.....	eL_E	7 27 45	.....	.....	.....	.....	
		F	7 50 00	.....	.....	.....	.....	
21	.....	iP	21 43 19	.....	.....	.....	6,925	
		PR	21 45 20	.....	.....	.....	.....	
		S	21 51 44	.....	.....	.....	.....	
		SR	21 55 15	.....	.....	.....	.....	
		L	22 01 40	.....	.....	.....	.....	F in microseisms.
24	.....	L_E	7 21 00	.....	.....	.....	.....	Record feeble, phases indistinct.
		F	8 00 00	.....	.....	.....	.....	
25	.....	e_E	18 28 00	.....	.....	.....	.....	
		S_E?	18 34 45	.....	.....	.....	.....	
		L_E	18 40 00	.....	.....	.....	.....	
		F	19 20 00	.....	.....	.....	.....	
30	.....	P	3 08 29	.....	.....	.....	5,080	
		S	3 15 15	.....	.....	.....	.....	
		SR	3 18 52	.....	.....	.....	.....	
		L	3 22 42	.....	.....	.....	.....	
		F	3 50 00	.....	.....	.....	.....	

SEISMOLOGICAL DISPATCHES.[1]

Kobe, Japan, December 1, 1916.

Damage caused by the earthquake of Sunday, November 25, which was briefly reported by cable, was considerably greater than was first indicated. It was the most severe in 25 years. Some of the Japanese earthquake experts believe the disturbance was due to the subsidence of subterranean fissures below the sea bottom, off the city of Kobe. (Assoc. Press.)

San Salvador, Republic of Salvador, December 20, 1916.

A volcanic explosion near the small village of Lower Verapaz, Guatemala, has caused the death of 15 persons. (Assoc. Press.)

Unionville, Nev., December 19, 1916.

Slight earth shocks were felt here on December 17th, 6:45 a. m. and on December 18th, 9 p. m., Pacific time. (Local observer.)

Redding, Cal., December 25, 1916.

Lassen Peak was in eruption to-day, emitting a great pillar of smoke. (Assoc. Press.)

Redding, Cal., December 28, 1916.

Two great pillars of smoke and steam poured from Lassen Peak to-day, rising almost vertically from the main crater and reaching an estimated height of 2,000 feet. The other smoke streamer from a smaller vent was about half as high. (Assoc. Press.)

[1] Reported by the organization indicated and collected by the seismological station at Georgetown University, Washington, D. C.

EARTHQUAKES FELT IN THE UNITED STATES DURING 1916.

By W. J. HUMPHREYS, Professor in Charge.

[Dated: Weather Bureau, Washington, D. C., Feb. 3, 1917.]

During 1916, 131 earthquakes strong enough to be felt were reported from different parts of the continental United States, as listed in the accompanying Table 1 and graphically represented (a dot for each report) on chart XI at the end of this issue of the REVIEW.

On February 21, a quake of intensity VI (Rossi-Forel), occurred near Asheville, N. C., that was reported from seven States. For further details see this REVIEW March, 1916, **44**; 154; also Taber in the Bulletin of the Seismological Society of America, v. **6**, p. 218.

On May 12 a quake of intensity VII, occurred near Boise, Idaho.

On October 18 a quake of intensity VII, occurred near Birmingham, Ala., that was reported from eight States. This is discussed in some detail by Finch and Hopkins in this issue of the REVIEW, p. 690–693.

None of these, however, did much damage; merely shook down some plaster, toppled over a few chimneys, and the like.

A few quakes of moderate intensities, V–VI, occurred in California, but none of them did any appreciable damage. A discussion by A. H. Palmer of the California earthquakes will appear in an early number of the Bulletin of the Seismological Society of America.

TABLE 1.—*Places in the United States reporting earthquakes during 1916.*

[Consult also Chart XI (XLIV–153).]

Place.	Approximate latitude (north).	Approximate longitude (west).	Number of quakes reported.	Place.	Approximate latitude (north).	Approximate longitude (west).	Number of quakes reported.
ALABAMA.	° ′	° ′		**ARIZONA.**	° ′	° ′	
Anniston	33 39	85 50	2	Clifton	33 04	109 17	1
Argo	33 42	86 31	2	Holbrook	34 54	110 08	1
Ashville	33 50	86 14	1	Nogales	31 20	110 52	1
Athens	34 50	86 59	1	Pinedale	34 19	110 15	1
Auburn	32 34	85 28	1	Pinto	35 05	109 38	1
Benton	32 19	86 47	1	Shumway	34 26	110 04	1
Bessemer	33 25	86 58	1	Snowflake	34 33	110 04	1
Birmingham	33 32	86 50	3	St. Michaels	35 38	109 05	1
Bridgeport	34 57	85 41	1	Thatcher	32 50	109 47	1
Calera	33 06	86 45	1				
Camden	32 00	87 16	1	**CALIFORNIA.**			
Camp Hill	32 46	85 37	1				
Clanton	32 49	86 39	1	Arrowhead Springs	34 15	117 16	1
Cordova	33 44	87 08	1	Avalon	33 27	118 22	1
Dadeville	32 48	85 44	1	Bakersfield	35 22	119 00	2
Decatur	34 36	87 00	1	Barrett	32 43	116 46	1
Easonville	33 32	86 16	1	Barstow	34 53	117 12	1
Eufaula	31 52	85 06	1	Beaumont	33 55	117 00	4
Florence	34 48	87 40	1	Bishop	37 21	118 22	1
Fort Deposit	31 59	86 36	1	Brawley	32 59	115 40	2
Gadsden	33 59	86 00	2	Bridgeport	38 18	119 15	1
Geneva	31 02	85 50	1	Cahuilla	33 32	116 43	5
Goodwater	33 04	86 03	1	Calexico	32 40	115 28	7
Guntersville	34 22	86 18	1	Camp Baldy	34 15	117 40	1
Hamilton	34 07	87 58	1	Claremont	34 07	117 44	5
Irondale	33 33	86 42	1	Coachella	33 40	116 10	1
Lincoln	33 36	86 03	2	Corona	33 52	117 35	1
Madison	34 41	86 43	1	Covelo	39 47	123 16	1
Maple Grove	34 09	85 49	1	Edison	35 21	118 53	1
Mentone	34 32	85 33	1	El Cajon	32 48	116 58	1
Montgomery	32 23	86 18	1	El Centro	32 50	115 32	1
Moulton	34 30	87 18	1	Eureka	40 48	124 11	3
Oneonta	33 55	86 29	1	Fairmont	34 45	118 25	2
Opelika	32 38	85 21	1	Fresno	36 43	119 49	1
Ozark	31 28	85 37	1	Gray	33 49	116 37	1
St. Bernard	34 11	86 48	1	Gray Mountain	34 38	116 15	2
Scottsboro	34 40	86 02	1	Hollister	36 50	121 20	4
Selma	32 05	87 01	1	Imperial	32 50	115 35	1
Talladega	33 26	86 05	1	Indio	33 43	116 12	1
Valley Head	34 32	85 32	2	Julian	33 05	116 37	2
Vernon	33 46	88 06	1	King City	36 14	121 00	2
Wedowee	33 18	85 29	1				

TABLE 1.—*Places in the United States reporting earthquakes during 1916*—Continued.

[Consult also Chart XI (XLIV–153).]

Place.	Approximate latitude (north).	Approximate longitude (west).	Number of quakes reported.
CALIFORNIA—continued.	° ′	° ′	
Livermore	37 40	121 45	1
Lonoak	36 20	120 55	3
Lone Pine	36 37	118 01	6
Los Alamos	34 45	120 15	3
Los Angeles	34 03	118 15	5
Los Gatos	37 12	121 58	3
Maricopa	35 05	119 08	2
Mecca	33 34	116 05	1
Merced	37 21	120 27	1
Mesa Grande	33 11	116 42	1
Mount Wilson	34 13	118 16	4
Nellie	33 22	116 52	3
Newhall	34 22	118 30	2
Niland	33 16	115 31	1
Nordhoff	34 35	119 14	1
Ozena	34 53	119 16	1
Pasadena	34 06	118 11	3
Paso Robles	35 31	120 40	2
Peachland	38 23	122 48	1
Point Loma	32 43	117 15	1
Pomona	34 04	117 44	1
Redlands	34 04	117 12	7
Rialto	34 12	117 27	2
Riverside	33 58	117 21	5
Rohnerville	40 33	124 11	2
Round Valley	37 24	118 37	1
Salinas	36 36	122 40	7
San Bernardino	34 07	117 19	3
San Diego	32 43	117 10	1
San Francisco	37 48	122 26	1
San Jose	37 20	121 54	3
San Luis Obispo	35 18	120 39	4
San Pedro	33 45	118 14	1
Santa Barbara	34 23	119 40	1
Santa Cruz	36 57	122 02	5
Santa Maria	34 58	120 28	1
Santa Monica	34 00	118 30	2
Shively	40 25	123 56	3
Sierra Madre	34 08	118 06	1
Spreckels	36 35	121 38	12
Surrey	35 23	118 32	1
Taft	35 07	119 26	2
Valley Center	33 13	117 03	1
Venice	34 00	118 30	2
Ventura	34 16	119 17	1
Victorville	34 32	117 18	4
Warner Springs	33 17	116 37	1
Yorba Linda	33 51	117 50	2
COLORADO.			
Frances	40 03	105 32	1
Grandlake	40 15	105 50	1
GEORGIA			
Atlanta	33 45	84 23	2
Augusta	33 28	83 54	2
Blairsville	34 54	83 58	1
Blue Ridge	34 52	84 21	1
Canton	34 14	84 29	2
Clarksville	34 36	83 30	1
Clayton	34 54	83 23	2
Cleveland	34 36	83 45	1
Columbus	32 28	85 00	2
Concord	33 05	84 26	1
Covington	33 36	83 48	1
Dahlonega	34 32	83 59	2
Dalton	34 46	84 58	1
Duluth	34 00	84 08	2
Forsyth	33 02	83 55	1
Gainesville	34 17	83 46	1
Gillsville	34 18	83 38	1
Griffin	33 16	84 18	1
Hiawassee	34 56	83 44	1
Kirkwood	33 46	84 18	1
La Fayette	34 42	85 18	1
La Grange	33 01	85 01	1
Macon	32 50	83 38	2
Madison	33 32	83 28	1
Marietta	33 56	84 32	1
Marshallville	32 27	83 55	1
Monticello	33 16	83 38	1
GEORGIA—con.	° ′	° ′	
Rome	34 15	85 10	1
Sandersville	32 56	82 48	1
Savannah	32 05	81 05	1
Summerville	34 28	85 20	1
Tallapoosa	33 45	85 18	1
Thomson	33 27	82 28	1
Thunder	32 56	84 30	1
Toccoa	34 34	83 19	1
Warrenton	33 21	82 37	1
Washington	33 41	82 46	1
IDAHO.			
Arrow Rock	43 35	116 05	1
Boise	43 37	116 14	4
Bonanza	44 17	114 42	1
Cambridge	44 32	116 37	1
Challis	44 30	114 16	1
Elk City	45 48	115 25	3
Emmett	43 51	116 34	1
Hailey	43 32	114 20	2
Idaho City	43 34	115 58	2
Lowman	44 08	115 41	1
Meridian	43 36	116 24	1
New Meadows	44 57	116 18	1
Payette	44 05	116 56	2
Pyle Creek	44 07	115 56	3
Salmon	45 13	113 55	1
Soldier	43 22	114 49	1
Weiser	44 15	116 58	1
ILLINOIS.			
Anna	37 27	89 18	1
Cairo	37 00	89 10	1
New Burnside	37 36	88 46	1
INDIANA.			
Evansville	37 58	87 33	1
Worthington	39 08	86 58	1
KENTUCKY.			
Beaver Dam	37 23	86 53	1
Calhoun	37 34	87 16	1
Hickman	36 35	89 12	1
Louisville	38 15	85 45	1
Mayfield	36 45	88 38	1
Middlesboro	36 36	83 43	1
Taylorsville	38 02	85 21	1
MISSISSIPPI.			
Aberdeen	33 50	88 26	1
Booneville	34 42	88 28	1
Corinth	34 56	88 25	1
Fulton	34 17	88 20	1
Portersville	32 42	88 22	1
Toomsuba	32 23	88 22	1
MISSOURI.			
New Madrid	36 35	89 32	2
NEBRASKA.			
Stapleton	41 33	100 28	1
NEVADA.			
Amos	41 26	117 48	1
Elko	40 51	115 45	2
Eureka	39 23	115 59	2
Fallon	39 30	118 48	1
Francis	39 44	119 58	1
Gerlach	40 38	119 24	1
Las Vegas	36 09	115 09	1
McDermitt	41 58	117 45	3
Millett	39 01	117 15	1
Pahrump	36 11	115 58	1
Paradise Valley	41 32	117 34	1
Rebel Creek	41 39	117 45	3
Reno	39 32	119 49	1
NEVADA—con.	° ′	° ′	
Rhyolite	36 52	116 50	1
Sharp	38 07	115 28	1
Tuscarora	41 18	116 13	1
Winnemucca	40 58	117 43	3
NEW MEXICO.			
Socorro	34 08	106 48	1
NEW YORK.			
Albany	42 39	73 45	1
Amsterdam	42 55	74 08	1
Ballston Lake	42 53	73 52	1
Eastchester	41 10	73 45	1
Glens Falls	43 21	73 36	1
Gloversville	43 04	74 20	1
Greenfield	43 09	73 50	1
Lake George	43 24	73 43	2
Little Falls	43 05	74 51	1
Mount Vernon	41 08	73 46	1
Scarsdale	41 10	73 45	1
NORTH CAROLINA.			
Altapass	35 53	82 00	1
Andrews	35 11	83 48	1
Asheville	35 36	82 32	1
Bat Cave	35 26	82 14	1
Black Mountain	35 41	82 24	1
Blantyre	35 16	82 36	1
Brevard	35 12	82 46	1
Brewers	36 22	81 06	1
Caroleen	35 15	81 50	1
Charlotte	35 13	80 51	1
Cullowhee	35 18	83 10	1
Elkin	36 14	80 51	1
Elizabethton	34 35	78 33	1
Franklin	35 10	83 22	1
Greensboro	36 05	79 50	1
Harmony	80 48	35 55	1
Henderson	36 20	78 25	1
Hickory	35 45	81 22	1
Highlands	35 02	83 15	2
Hot Springs	35 53	82 50	1
Lake Toxaway	35 05	82 56	1
Lenoir	35 55	81 36	2
Lincolnton	35 27	81 18	2
Marion	35 54	82 02	1
Marshall	35 47	82 40	1
Morganton	35 45	81 38	2
Mount Airy	36 30	80 38	1
Murphy	35 06	84 00	1
Nantahala	35 17	83 43	1
Newton	35 42	81 14	1
N. Wilksboro	36 08	81 13	1
Pinehurst	35 12	79 29	1
Raleigh	35 45	78 37	1
Salisbury	35 38	80 32	1
Saluda	35 14	82 20	1
Settle	35 59	80 44	1
Skyland	35 30	82 30	1
Southport	33 55	78 02	1
Statesville	35 45	80 55	1
Swannanoa	35 36	82 23	1
Taylorsville	35 53	81 12	1
Wilmington	34 14	77 57	1
Winston-Salem	35 06	80 17	1
OREGON.			
Newport	44 38	124 08	1
SOUTH CAROLINA.			
Anderson	34 30	82 39	1
Batesburg	33 50	81 38	1
Belton	34 30	82 34	1
Calhoun Falls	34 05	82 36	1
Chappells	34 09	81 52	1
Charleston	32 47	79 56	3
Clemson College	34 39	82 52	1
Columbia	34 00	81 03	2
SOUTH CAROLINA—con.	° ′	° ′	
Gaffney	35 08	81 36	1
Greenville	34 50	82 24	1
Greenwood	34 10	82 10	1
Honea Path	34 25	82 23	1
Landrum	36 14	82 15	1
Liberty	34 47	82 41	2
Little Mountain	34 09	81 24	1
Mountain Rest	34 52	83 09	1
Newberry	34 16	81 39	1
Rock Hill	34 54	81 05	1
Santuck	34 35	81 35	1
Spartanburg	34 52	81 58	1
Summerville	33 03	80 14	6
Walhalla	34 45	83 04	1
Westminster	34 38	83 06	1
SOUTH DAKOTA.			
Pine Ridge	43 02	102 32	1
Winner	43 24	99 53	1
TENNESSEE.			
Bluff City	36 27	82 13	1
Bristol	36 36	82 12	1
Carthage	36 16	85 56	1
Charleston	35 17	84 45	2
Chattanooga	35 04	85 14	2
Clinton	36 05	84 07	1
Copperhill	35 00	84 22	2
Elizabethton	36 20	82 10	1
Knoxville	35 56	83 58	1
Lewisburg	35 27	86 48	1
Loudon	35 44	84 21	1
Lynnville	35 24	87 02	1
McMinnville	35 40	85 48	2
Murfreesboro	35 53	86 26	1
Nashville	36 10	86 47	1
Newport	35 56	83 12	1
Rogersville	36 25	83 00	1
Sewanee	35 13	85 53	1
Sevierville	35 50	83 33	1
Sparta	35 56	85 27	1
Tullahoma	35 23	86 14	1
Walling	35 48	85 35	1
Waynesboro	35 18	87 45	1
UTAH.			
Elberton	39 58	111 58	2
Santaquin	40 00	111 46	1
VIRGINIA.			
Danville	36 35	79 32	1
Lynchburg	37 25	79 09	1
Norfolk	36 51	76 17	1
Richmond	37 32	77 27	1
Roanoke	37 15	79 57	1
South Boston	36 43	78 57	1
Wytheville	36 56	81 05	1
WASHINGTON.			
Cedar Falls	47 24	121 49	1
Marietta	48 47	122 35	1
Olympia	47 02	122 55	1
Seattle	47 38	122 20	1
Silverton	48 00	121 32	2
Sumner	47 12	122 13	2
WISCONSIN.			
Madison	43 05	89 21	1
WYOMING.			
Atlantic	42 30	108 45	1
Rongis	42 25	107 50	1

SECTION VI.—BIBLIOGRAPHY.

RECENT ADDITIONS TO THE WEATHER BUREAU LIBRARY.

C. FITZHUGH TALMAN, Professor in Charge of Library.

The following books have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological and seismological work and studies:

Alaska agricultural experiment stations.
Annual report, 1915. Washington. 1916. 100 p. plates. fold. map. 23½ cm.

Austria-Hungary. Hydrographisches Amt der kaiserlichen und königlichen Kriegs-Marine in Pola.
Jahrbuch der meteorologischen, erdmagnetischen und seismischen Beobachtungen, 1915, v. 20. Pola. 1916. 152 p. 33½ cm.

Bates, D. C.
Climate and meteorology [of New Zealand]. (Excerpted from New Zealand. Official year-book, 1914, section 2, p. 69–90.)

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(Koninklijk magnetisch en meteorologisch observatorium te Batavia. Verhandelingen, no. 4.)

Blackwood, O. H.
Determination of the diurnal variation of the radio-activity of the atmosphere in Manila by the active deposit method. (Excerpted from the Philippine journal of science, v. 10, sec. A, no. 1. January, 1915, p. 37–47.)

Brennan, J. F.
Cloud drift as observed at Kingston, Jamaica, during the years 1907–1913. Jamaica. 1916. 9 p. 34 cm.

Christy, Miller, & Marriott, William.
Audibility of the gun-firing in Flanders over the southeast of England, September, 1914–April, 1916. (Reprinted from the Quarterly journal of the Royal meteorological society, v. 47, no. 180, October, 1916, p. 267–288.)

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Regenwaarnemingen op Sumatra's oostkust en de oostkust van Atjeh van af 1875. Medan. 1915. 640p. 27 cm. (Bulletin van het Deli proefstation, 1915, no. 6.)

Dutch West Indies. Department van den Landbouw in Suriname.
Meteorologische Waarnemingen . . . Suriname in Curaçao, 1914–1915. Amsterdam. 1915–1916. unpaged. 14½ cm.

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Calcul de la température moyenne mensuelle de l'air aux stations météorologiques suédoises. [Swedish and French text]. Uppsala. 1916. 111 p. 31 cm. (Sweden. Statens meteorologiska central-anstalt. Meteorologiska iakttagelser i sverige, 1914.)

Eredia, Filippo.
Aviazione e meteorologia. Roma. 1916. 14p. 21 cm. (Estratto da "Conferenze e prolusioni," fasc. n. 19, 1° Ottobre, 1916.
Le nebbie in Val Padana. Roma. 1916. 12 p. 26 cm. (Estratto dalla Revista meteorico-agraria, anno 37, no. 10.)
Strumenti e osservazioni di meteorologia con norme sul servizio meteorico nelle colonie. Firenze. 1916. 162p. 24½ cm. (Estratto da "L'agricultura coloniale," 1916, v. 10.)
Sul clima di Ghadàmes. Roma. 1916. 25p. 23½ cm. (Estratto dal Bollettino informazioni del Ministero delle colonie, 1916, numeri 4–6.)
Sul clima di Salonicco. Roma. 1916. 23 p. 23 cm. (Estratto dal Bollettino della Reale società geografica italiana, 1916, fasc. 12, p. 986–1006.)

Guinchard, J. ed.
Sweden: historical and statistical handbook; 2d. ed. Eng. issue. Stockholm. 1914. 2 v. illus. 25 cm. [Climate, v. 1, p. 31–46.]

Hamrick, Andrew.
Honolulu weather. (Excerpted from Paradise of the Pacific, 1916, v. 29, no. 12, p. 9–13.)

Harris, F[rederick] S., and Robinson, J. S.
Factors affecting the evaporation of moisture from the soil. Washington. 1916. 26 cm. (Reprinted from the Journal of agricultural research, v. 7, no. 10.)

Knoche, Walter.
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Mysore. Meteorological department.
Meteorology in Mysore for 1915. Bangalore. 1916. 56 p. fold. diagram. 31 cm.

New York central lines.
Forecast and chart of mild and cold winters. New York. 1916. 1 sheet. 26½ cm.

Oakenfull, J. C.
Brazil. Frome, Eng. 1913. viii, 604 p. front. plates. 3 fold. maps. 19 cm. (Climate and diseases, p. 17–30. Temperature data, p. 544–563.)

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Philippine Islands. Weather bureau.
Annual report of the director. Manila. 1916. 143 p. 29½ cm.

Rio Grande do Sul. Instituto astronomico e meteorologico da Escola de engenharia de Porto Alegre. Secção de meteorologia.
Dados meteorologicas, 1914. Porto Alegre. 1915. 50 p. maps. 32½ cm.

Russia. Observatoire physique centrale.
Observations des stations météorologiques du réseau de l'observatoire météorologique de Vladivostok, 1914. Vladivostok. 1915. various pagings. 32½ cm.

Shaw, [William] Napier.
The weather map: an introduction to modern meteorology. London. 1916. 94 p. diagrams. fold. map. 15 cm.

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With Scott: the silver lining. New York. 1916. 464 p. front. plates. fold. map. 24 cm. [Contains various notes on meteorology.]

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Tondorf, F. A.
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Wells, P. V., & Thuras, A. L.
Report on an investigation of fog in the vicinity of the Grand banks of Newfoundland done aboard the ice patrol cutter "Seneca" during the May cruise, 1915. 23 cm. (In U. S. Coast guard. International ice observation and ice patrol service in the North Atlantic ocean, Feb.–July, 1915. Bulletin no. 5, p. 65–77.) **[Reprinted in a later issue of this REVIEW.]**

RECENT PAPERS BEARING ON METEOROLOGY AND SEISMOLOGY.

C. FITZHUGH TALMAN, in Charge of Library.

The following titles have been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected are of papers and other communications bearing on meteorology and cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled. It shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau.

American museum journal. New York. v. 16. December, 1916.

Reeds, Chester A. A perplexing phenomenon—mirage. p. 513–524.

American photography. Boston. v. 11. January, 1917.

Anderson, E. S. Snow photography. p. 3–6.

Engineering news. New York. January 4, 1917.

The Miami valley flood-protection work. I. Fixing maximum flood limits. p. 12–17.

Geographical journal. London. v. 49. January, 1917.

Kellas, A. M. A consideration of the possibility of ascending the loftier Himalaya. p. 26–48. [Discusses physiological effects of great altitudes.]

Nature. London. v. 98. December 28, 1916.

Shaw, Napier. Prof. Cleveland Abbe. p. 332. [Obituary.]

Physical review. Lancaster. v. 8. December, 1916.

Harrington, Ertle Leslie. A redetermination of the absolute value of the coefficient of viscosity of air. p. 738–751.

Royal meteorological society. Quarterly journal. v. 42. October, 1916.

Bonacina, L. C. W. On the readjustment of pressure differences; two species of atmospheric circulation and their connection. p. 209–228.

Shaw, Napier. Note on Mr. Bonacina's paper "On the readjustment of pressure differences; two species of atmospheric circulation and their connection." p. 229–231.

Clark, J. Edmund, & Adames, Henry B. Report on the phenological observations in the British islands, from December, 1914, to November, 1915. p. 233–265.

Christy, Miller, & Marriott, William. Audibility of the gunfiring in Flanders over the southeast of England, September, 1914–April, 1916. p. 267–288.

Chapman, E. H. The relation between atmospheric pressure and rainfall at Kew and Valencia observatories. p. 289–299.

Curtis, R. H., & Marriott, Wm. Robert Henry Scott, F. R. S. 1833–1916. p. 301–304. [Obituary.]

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Cyclonic disturbances and their effect. An explanation of the air currents involved. p. 28–29. (Jan. 13.)

Wayfarer (*pseud.*). Old English weather vanes. Some curious mediæval finial decorations. p. 53–54. (Jan. 27.)

Breton, A. A new condensation hygrometer. p. 60. (Jan. 27.)

Seismological society of America. Bulletin. Stanford university. v. 6. December, 1916.

Wood, Harry O. The earthquake problem in the western United States. p. 197–217.

Taber, Stephen. The earthquake in the southern Appalachians, February 21, 1916. p. 218–226.

Montessus de Ballore, [Fernand] de. Earthquake intensity scales. p. 227–231.

Tristan, J. Fidel. The Costa Rica earthquake of February 27, 1916. p. 232–235.

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Hann, J[ulius] v. Beiträge zur Kenntnis des jährlichen und täglichen Ganges der Temperaturabnahme mit der Höhe im Gebirge. p. 492–503.

Defant, Albert. Die täglichen unperiodischen Druckschwankungen im Gebiete der Vereinigten Staaten von Nordamerika. p. 503–510. [See translation in a later issue of this REVIEW.]

Linke, Franz. Die atmosphärische Quelle der durchdringenden Strahlung. Zweite Mitteilung. p. 510–513.

S., C. Aksel Steen. p. 513–514. [Obituary.]

Köppen, W[ladimir]. Nachruf für A. J. Woeikof. p. 514–515. [Obituary.]

Maurer, J[ulius]. Zur atmosphärisch-optischen Störung des Sommers 1916. p. 515–517.

Wolf, Max. Ueber die höchsten Dämmerungswolken. p. 517–519.

Láska, V[aclav]. Abnormale Dämmerungserscheinungen im Sommer 1916. p. 520–521.

Pettersson, Hans. Die experimentelle Darstellung von Seiches in Gasen. p. 521–522.

Wegener, Alfred. Aeussere Hörbarkeitszone und Wasserstoffsphäre. p. 523–524.

Quelle, O[tto]. Regenmengen im Staat Ceará, Nord-Brasilien. p. 524–525. [Collected data for Quixeramobin and Icó.]

SECTION VII.—WEATHER AND DATA FOR THE MONTH.

THE WEATHER OF THE MONTH.

P. C. DAY, Climatologist and Chief of Division.

[Dated: Weather Bureau, Washington, D. C., Feb. 2, 1917.]

PRESSURE AND WINDS.

The distribution of the mean atmospheric pressure over the United States and Canada, and the prevailing direction of the winds are graphically shown on Chart VII, while the average values for the month at the several stations, with the departures from the normal, are shown in Tables I and III.

For December as a whole the barometric pressure averaged below the normal throughout the entire country, including the Canadian Provinces, except in the extreme northwest and in British Columbia where at a few points the averages were normal or slightly above. In the South Atlantic States, along the Pacific coast, and over the northern border States to the westward of the Great Lakes, the departures from normal were generally small, but they were quite pronounced in the central portions of the Rocky Mountain region, in New England, and the Canadian Provinces to the northeast, being greatest in the latter district.

The month opened with relatively low pressure in the northern border States, the Canadian Provinces, and to the west of the Rocky Mountains. Low pressure predominated generally for the next several days; but from about the middle of the first to the middle of the second decade—except for the occasional passage of a low area—the pressure was generally above the normal over most of the central, southern, and western portions of the country. At the same time relatively low pressure obtained in most northern districts. The remainder of the second and most of the third decade were marked by the passage across the country of several rather extensive and well-defined low pressure areas, and while each in turn was followed by relatively high pressure, the tendency was to readings below the average except in the more northern districts. During the last few days of the month high pressure areas overspread almost the entire country, and the month closed with barometer readings above the normal in practically all districts.

The distribution of the HIGHS and LOWS was generally favorable for westerly and southwesterly winds in the region of the Great Lakes and in the Ohio Valley. In the New England and Middle Atlantic States and the upper Mississippi and lower Missouri Valleys northerly and northwesterly winds were favored, while in the Gulf States southerly winds were frequent. Elsewhere variable winds prevailed.

TEMPERATURE.

December opened with moderate temperature in all districts, but there was a general increase thereafter, and the first decade was unusually warm in all districts east of the Rocky Mountains, specially on the 3d, in the Central and Southern States, and on the 4th and 5th in the eastern and northern districts. During the second decade the conditions were reversed, cold waves overspreading the central districts on the 11th and 20th, and in portions of the upper Mississippi and lower Missouri Valleys the temperatures daily averaged from 15 to 17 degrees below the normal. In the third decade low temperatures continued in the West and Northwest, a severe cold wave overspread the central districts on the 27th, and the month closed with cold weather over the greater part of the country. The temperature for the decade as a whole was above the average in the Gulf and South Atlantic States, but it was below throughout the North and West, particularly in Montana, where the averages were daily 25 degrees or more below the normal.

For the month as a whole the temperature was much lower than the normal in Montana, the western portions of the Dakotas, and in practically all central, northern, and western districts. The month was slightly warmer than the normal along the Gulf coast and in parts of the Atlantic States.

PRECIPITATION.

At the beginning of December fair weather prevailed over most of the country, except on the Pacific coast and in some northeastern sections. Rain occurred from the lower Ohio Valley northeastward on the 4th, and considerable rainy weather obtained from the 6th to the 10th. There was much stormy weather during the remainder of the month, with considerable snow in the Central and Northern States, the snow drifting badly in the upper Mississippi Valley and western Lake region. The month closed with fair weather over the greater part of the country.

For the month as a whole the precipitation was moderate to fairly heavy over most of the country east of the Mississippi River and also in Arkansas and Louisiana. Over much of the central valleys and Plains region the precipitation was in the form of snow, which melted slowly, thus being of maximum benefit to the soil. In the Plains States from Nebraska southward the month was dry, specially in central and western Texas, where large areas reported no measurable precipitation during the entire month. In most of Colorado and Wyoming, especially near the Continental Divide, the precipitation was rather heavy, also in much of Idaho and Montana, northern Utah, and in Arizona the falls were moderate to heavy. In the Pacific States, where the month is normally one of the wettest of the year, the precipitation was generally near or above the normal on the coast, while in the interior the falls were usually less than the average, but there was almost everywhere ample moisture for present needs.

SNOWFALL.

Snow was heavy in the Rocky Mountains and most northern districts. In portions of Oregon and Washington greater depths than usual were reported from the higher altitudes and similar conditions existed in Wyoming and surrounding States. The greatest depths reported were in the Cascade ranges where the total falls for the month in some cases exceeded 10 feet.

A fairly good covering of snow remained on the ground over the winter-grain region during much of the month, affording fair protection to wheat. Likewise the lower elevations in the mountain regions of the West were covered for considerable periods and much feeding of stock was necessary.

RELATIVE HUMIDITY.

December was generally drier than the average in the portions of the country to the eastward of the Great Plains, except over relatively small areas along the northern border, and in the central Gulf States. Over much of the Great Plains and Rocky Mountain regions, and the southern portion of the Pacific Coast States the relative humidity was above the average, elsewhere it was near the average.

GENERAL SUMMARY.

The first decade of the month was favorable for farm work, except in the extreme Northwestern States, but during the balance of the month field work was possible, as a rule, only in the more southern portions of the country, and dry and cold weather hindered plowing and seeding in those districts to some extent. Winter grains were well protected by snow during the greater part of the month in northern and northeastern districts, but in the Southwest cold weather did some injury to winter wheat, and the lack of precipitation was unfavorable for grain in Texas. There was considerable damage to the more tender truck crops by the cold weather of the middle and latter parts of the month in most Southern States and vegetation was unfavorably affected by dry weather in the Southwest. The unseasonably low temperature favored ice harvesting in the Northern States.

SEVERE LOCAL STORMS.

The following notes regarding severe storms have been extracted from the monthly reports of the several States.

Arkansas.—Moderate tornadoes were reported at Hardy and Stuttgart, Ark., on the 7th, by which 8 persons were injured and some property destroyed. A severe tornado, by which 17 persons were killed, a large number injured, and property valued at over $100,000 was destroyed, occurred on the 26th. It followed a nearly straight course from Leola, Grant County, Ark., to Des Arc, Prairie County, Ky., a distance of over 85 miles. The tornado was accompanied by heavy rainfall, extending to the eastern and northern borders of the State, 24-hour falls of from 3 to 5 inches occurring at a number of places. A slight tornado was also reported at Lake Village, Ky., on the 26th, in which one person was injured and some property destroyed.

Kentucky.—A tornado and hailstorm occurred in the vicinity of Calhoun, Ky., on the 4th. The course of the storm was nearly east. Two heavy hailstorms occurred, the first about 2:30 p. m., some of the hail being as large as partridge eggs, but irregular in shape, and the second about 3 p. m., with hailstones about one-fourth inch in diameter and almost perfectly round, which covered the ground. The tornado occurred during the first hailstorm and the funnel-shaped cloud seemed to come out of the southwest corner of the storm, about 3 miles south of Calhoun. The path of the tornado, as marked on the earth, varied between 7 and 300 yards in width, and was several miles in length. Several dwellings and a number of outbuildings were destroyed. No lives were lost, although there were several narrow escapes. A schoolhouse was completely destroyed, but the storm occurred during a recess period, when the pupils were on the playground, and they with the teacher sought shelter in a protecting cove, and thus escaped.

During a blinding snowstorm on the 22d, a residence near Danville, Ky., was struck by lightning and completely wrecked. The occupants were severely shocked.

Average accumulated departures for December, 1916.

Districts.	Temperature.			Precipitation.			Cloudiness.		Relative humidity.	
	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure from the normal.	General mean for the current month.	Departure from the normal.
	°F.	°F.	°F.	In.	In.	In.	0–10		P. ct.	
New England	28.8	−0.7	− 5.2	3.24	−0.10	− 4.90	5.7	−0.4	73	− 3
Middle Atlantic	34.8	−0.4	+ 7.2	3.51	+0.40	− 5.40	5.4	−0.4	69	− 6
South Atlantic	48.4	+1.3	+12.3	2.52	−1.10	−12.90	4.6	−0.3	73	− 5
Florida Peninsula	67.9	+2.0	+ 0.6	0.64	−1.40	−14.00	3.3	−1.4	79	− 3
East Gulf	50.7	+1.5	+10.4	4.90	+0.40	− 2.20	5.6	+0.1	77	0
West Gulf	49.8	+1.2	+14.4	1.13	−1.70	− 8.50	4.9	−0.3	69	+ 4
Ohio Valley and Tennessee	34.8	−1.8	+ 2.4	3.45	0.00	− 2.40	5.7	−0.6	73	− 3
Lower Lakes	27.1	−2.0	− 1.1	2.54	−0.40	− 3.70	7.4	−0.3	74	− 4
Upper Lakes	20.3	−4.1	− 1.6	2.16	+0.10	+ 2.00	6.4	−0.9	82	0
North Dakota	2.8	−9.0	−22.0	1.27	+0.60	+ 0.10	4.7	−0.7	85	+ 6
Upper Mississippi Valley	23.2	−4.1	+ 2.1	1.46	−0.30	− 1.90	5.2	−0.6	76	− 2
Missouri Valley	22.4	−4.5	+ 6.4	0.90	−0.20	− 6.00	4.8	−0.4	74	− 1
Northern slope	14.3	−9.4	−24.4	1.24	+0.40	+ 0.60	5.9	+0.7	74	+ 6
Middle slope	29.9	−3.0	+ 2.1	0.67	−0.10	− 4.00	4.3	+0.2	66	0
Southern slope	43.5	−1.0	+13.1	0.33	−0.50	− 5.20	3.3	−1.7	51	−15
Southern Plateau	38.4	−3.7	− 8.9	0.71	0.00	+ 1.00	2.9	−0.3	50	+ 7
Middle Plateau	26.8	−4.5	−14.6	0.89	−0.10	+ 0.50	5.4	+0.6	68	+ 2
Northern Plateau	26.4	−5.6	−26.5	1.75	0.00	+ 0.70	7.8	+1.0	79	− 1
North Pacific	38.8	−3.4	−13.2	5.49	−2.20	−11.90	8.6	+0.8	87	+ 1
Middle Pacific	45.0	−3.6	− 9.4	4.41	0.00	− 1.80	5.1	−0.3	78	− 3
South Pacific	50.0	−3.0	− 9.2	4.00	+1.80	+ 6.60	4.6	+0.3	72	+ 3

WEATHER CONDITIONS ON THE NORTH ATLANTIC DURING DECEMBER, 1915.

The data presented are for December, 1915, and comparison and study of the same should be in connection with those appearing in the REVIEW for that month (cf. Chart III, Dec., 1915, XLIII–134). Chart IX (XLIV–153) shows for December, 1915, the averages of pressure, temperature, and the prevailing direction of the wind at 7 a. m., 75th meridian time (Greenwich mean noon), together with notes on the locations and courses of the more severe storms of the month.

PRESSURE.

The distribution of the average monthly pressure, as shown on Chart IX, presents few unusual features. The North Atlantic or Azores HIGH, with a crest of 30.15 inches, was practically normal as to position, extent, and intensity, while the continental HIGH was south of its usual position, the crest of 30.15 inches being central in southeastern Georgia.

A well-defined area of low pressure surrounded by an isobar of 29.5 inches, extended from the Irish coast to the thirty-seventh meridian, and from the fiftieth to the fifty-seventh parallel. The lowest average monthly pressure reading for any 5-degree square was 29.47 inches, and occurred in the square between latitude 50°–55° N. and longitudes 25°–30° W., where the lowest individual reading during the month was 28.60 inches, on the 30th, and the highest 30.22, on the 11th. The highest average monthly pressure was 30.16 inches, and occurred in the square that includes the Madeira Islands, where the daily readings ranged from 29.82 inches on the 27th, to 30.46 inches on the 13th. Over the eastern part of the ocean the gradients of mean monthly pressure between the upper and lower latitudes were somewhat steeper than usual, while over the western division they were practically normal.

The usual rapid winter pressure changes were in some cases very marked, and in one 5-degree square in the northeastern part of the ocean, the barometer rose from 28.70 inches, on the 8th, to 30.40 inches, on the 12th.

In this same locality the mean barometric readings for the first and last decades of the month were 29.26 inches and 29.21 inches, respectively, while for the middle period it was 30 inches. In the 5-degree square between latitude 40°–45°, longitude 35°–40°, the average for the first decade was 29.42 inches, the second 30 inches, and for the last 11 days, 29.72 inches.

In the waters adjacent to the American coast, between the fortieth and forty-fifth parallels, the averages are as follows: First decade, 29.97 inches; second decade, 29.83 inches; and for the last 11 days, 30.03 inches. In southern waters, the variation in pressure from day to day was, as usual, not large and the averages for the three decades of the month differed but slightly.

GALES.

December is usually one of the stormiest months of the year, and in December, 1915, the number of days on which gales were reported was considerably above the normal over the greater part of the ocean north of the thirty-fifth parallel, and in the territory between the thirtieth and thirty-fifth parallels, west of the Bermudas. The greatest number of gales reported from any 5-degree square was 11, a percentage of 35, and occurred in the square between latitudes 35°–40°, longitudes 60°–65°, where the normal percentage is 19. Along the American coast between Hatteras and Halifax, they were reported on from 7 to 9 days, which was considerably above the normal.

On December 1, 1915, a well-developed area of low pressure (1 on Chart IX) was central near latitude 43, longitude 30. On the same date a second LOW had its center about 200 miles southeast of Halifax, and a third surrounded Ireland with the isobar of 29.1 inches extending as far east as Liverpool. One vessel near the Scilly Islands, and another a short distance southeast of Brest, France, reported westerly and northwesterly gales of 48 and 54 miles, respectively, while no winds of gale force were reported from the vicinity of the other two depressions. On December 2, the first disturbance (LOW 1) was central near latitude 48°, longitude 24°, and while the barometer had fallen to 29.10 inches, only moderate winds prevailed; the second LOW had disappeared; the third was central somewhere in the North Sea, although it was impossible to plot its position accurately on account of lack of observations. During the next 24 hours LOW 1 moved a short distance in a northeasterly direction, and the extent of its area had contracted to a marked degree; the lowest barometer reading had fallen to 28.93 inches, and 3 vessels near the center reported westerly gales of from 40 to 50 miles. The course of this disturbance then assumed an easterly direction, and on the 4th the center was near latitude 50°, longitude 17°, where moderate winds prevailed. It then curved toward the northeast, and on the 5th was near the west coast of Ireland, the winds remaining moderate in force and the barometer changing but little. On this date a second LOW was central near latitude 41°, longitude 49°; a number of vessels encountered moderate to strong gales, and the storm area covered a narrow belt between the forty-fifth meridian and the American coast. During the next 24 hours the northerly movement of LOW 1 was slight, while its intensity increased, as the barometer had fallen to 28.81 inches on the 6th, and two vessels reported unusually heavy gales of 75 and 90 miles an hour, respectively. By this time the second LOW had moved to about 5 degrees due east of its position on the 5th, and the conditions of wind and weather remained practically the same, as moderate gales were reported in the west southwest quadrants. Continuing with a nearly uniform rate of speed and direction, LOW 1 was central on the 7th near Stornaway, Scotland, where the barometer had fallen to 28.70 inches, and heavy gales prevailed between that point and the twentieth meridian. The second LOW remained practically stationary and the storm area was somewhat larger than on the previous day, with a falling barometer. The course of LOW 1 then curved toward the east and on the 8th the area of low pressure covered the western part of the Scandinavian peninsula; the pressure was somewhat higher than on the 7th, although strong gales still existed between the fifth and thirteenth meridians, west longitude. The second LOW had moved rapidly in a northeasterly direction, and on the 8th the center was near latitude 47°, longitude 33°; the storm area had contracted somewhat in area, although northeasterly gales accompanied by hail were reported between the thirty-seventh and forty-seventh meridians. This storm then turned toward the north, increasing in intensity all the time, and on the 9th the center was near latitude 53°, longitude 30°; the barometer now read 28.60 inches, and the maximum wind velocity ranged from 60 to 75 miles an hour.

On December 9 a LOW (II on Chart IX) of limited extent was central near latitude 43° N., longitude 66° W., and northeasterly gales extended as far south as the thirtieth parallel in the vicinity of the American coast, and hail was reported by one vessel. By the 10th this disturbance had moved about 10 degrees due east of its position on the 9th, increasing somewhat in intensity and extent; a number of vessels encountered violent southerly gales between the forty-seventh and fifty-first meridians, while heavy northwesterly winds, accompanied by hail and snow again prevailed along the American coast between Boston and Hatteras.

On December 11 this disturbance was in the vicinity of Saint Johns, Newfoundland, where the barometer read 28.68 inches; fog was reported by two vessels about 5 degrees southeast of that point, although heavy southeasterly gales prevailed between the fortieth and fiftieth parallels and the thirty-fifth and fortieth meridians, and northwest winds of nearly as high velocity were encountered in the southwest quadrant between the thirty-fifth and forty-fifth parallels, west of the sixtieth meridian. By the 12th the LOW had moved to a position near latitude 50°, longitude 47°. Two narrow belts of heavy winds extended from the center of this disturbance; the first toward the southwest to a point about 5 degrees east of Halifax, and the second due east to the thirtieth meridian, while in the territory between the two belts, moderate southwest winds prevailed. This storm continued in a northeasterly direction, and on the 13th the center was apparently near latitude 56°, longitude 34°, where two ships recorded westerly gales of 50 miles an hour, the storm area extending as far south as the forty-eighth parallel.

On December 13 a second LOW (III on Chart IX) was central 3 degrees east of Norfolk; it was of small area and light intensity, with moderate winds. This LOW moved rapidly, and on the 14th occupied the region between Halifax and Boston, the center being near Portland, while westerly gales of from 40 to 55 miles an hour occurred in a narrow strip along the coast as far south as Hatteras. On the 15th Halifax was the center of the depression, and the storm area was almost the same in extent as on the day before, while snow was reported by two vessels in the southwest quadrant. On the 16th and 17th this disturbance was near St. Johns, Newfoundland, and the wind had moderated considerably since the 15th, while

snow and hail were reported by one vessel on the 16th, and snow on the 17th.

On December 19 a well-developed depression covered Newfoundland; a number of vessels between the fortieth and forty-fifth parallels reported strong westerly gales, although in the waters adjacent to the American coast the winds were from light to moderate. This LOW moved slowly in an easterly direction, and on the 25th was central over Ireland. The track of this disturbance was so far north that it was impossible to locate the position of its center due to lack of reports, until the 24th, when it was near latitude 55° N., longitude 14° W. On the 22d and 23d moderate to very heavy gales prevailed along the greater part of the northern steamer tracks and one vessel on the 22d, near latitude 45°, longitude 47°, reported a southwesterly hurricane of 90 miles an hour, although 65 miles was the highest velocity recorded by any other vessel in the vicinity. On the 24th high winds prevailed over a large territory between the fortieth and fiftieth parallels, and the tenth and fortieth meridians, while one vessel encountered fog in the Irish Channel. On the 25th there were a few scattering reports of gales in the eastern part of the ocean, although for the most part the winds were of moderate force with considerable rain and snow between the twenty-fifth and fortieth meridians. On the 26th, Boston, with a pressure reading of 28.92 inches, was the center of a severe disturbance; two vessels about 2 degrees south of the center encountered southwest winds of 75 miles an hour, while winds of gale force covered a narrow strip extending as far south as the thirty-fourth parallel, and as far east as the sixty-second meridian. On the 27th this disturbance was central near St. Johns, Newfoundland, and while the maximum velocity of the wind was not as high as on the day before, moderate to strong gales still prevailed in the southerly quadrants. On the same day a second LOW covered the southern part of Ireland, extending to the west coast of England. Two vessels about 3 degrees south of the center reported westerly gales of 75 miles an hour, and scattering reports indicated that winds of gale force existed as far south as the Azores. On December 28 the first LOW was near latitude 55°, longitude 40°, having changed but little in intensity, although the storm area had contracted somewhat since the previous day. The second LOW was probably near Denmark, although it was impossible to locate it accurately on account of lack of observations.

On December 30 a restricted area of low pressure was central near latitude 43°, longitude 56°; northeasterly gales with a maximum force of 55 miles an hour occurred near the center, accompanied by hail and snow. On this date a second LOW was in the vicinity of latitude 52°, longitude 27°. This was much more extensive than the first, and while the highest force of the wind was about the same as on the day before, the storm area extended from the forty-second to the fifty-second parallels, and from the twentieth to the forty-second meridians. On December 31 these two depressions had evidently combined, as on that date only one area of low pressure existed, and that covered a large territory from the west coast of Ireland to the fortieth meridian, and from the forty-fifth to the sixtieth parallels. The storm area was not as large as on the previous day, and a number of observations showing winds of moderate velocity were interspersed with those of gale force.

TEMPERATURE.

The mean monthly temperature of the air over the ocean, was, as a whole, somewhat above the normal, although there were small negative departures in the region between the forty-fifth and fiftieth parallels, and the fifteenth and twenty-fifth meridians. In the waters adjacent to the American coast, temperatures were considerably above the normal north of the fortieth parallel, while they decreased toward the south, reaching the minimum at Hatteras, where the departure was −4.1 degrees. The temperature increased gradually from the thirty-fifth parallel southward along the Florida coast, and in the Gulf of Mexico the departures ranged from +1 to +4 degrees.

The temperature departures at a number of Canadian and United States Weather Bureau stations on the Atlantic and Gulf coasts were as follows:

	°F.		°F.
St. Johns, N. F.	+4.1	Norfolk, Va.	−2.5
Sydney, C. B. I.	+5.0	Hatteras, N. C.	−4.0
Halifax, N. S.	+4.5	Charleston, S. C.	−3.1
Eastport, Me.	+4.3	Key West, Fla.	−1.7
Portland, Me.	+2.3	Tampa, Fla.	−1.1
Boston, Mass.	+2.6	Pensacola, Fla.	+0.9
Nantucket, Mass.	−1.1	New Orleans, La.	+2.3
Block Island, R. I.	−1.6	Galveston, Tex.	+1.6
New York, N. Y.	−0.9	Corpus Christi, Tex.	+4.6

FOG.

There was considerably less fog than usual during December 1915. Off the banks of Newfoundland the normal percentage of days with fog is from 30 to 35, while in the same region during December, 1915, it was reported on three days, a percentage of 10. Over the western part of the sailing routes fog was reported on from one to two days, while the eastern portion was practically free.

PRECIPITATION.

The largest number of days on which hail was observed in any one 5-degree square, was four, between latitude 45°–50°, and longitude 35°–40°; while snow was reported on five days in the square that includes Halifax, Nova Scotia. The eastern part of the North Atlantic was comparatively free from hail and snow, and south of the thirty-fifth parallel, hail alone was reported on one day.

Maximum wind velocities during December, 1916.

[Velocities below 50 mi./hr. (22.4 m./sec.) are not included.]

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
		Mi./hr.				*Mi./hr.*	
Block Island, R. I.	6	56	nw.	Nantucket, Mass.	15	59	ne.
Do.	7	60	nw.	Do.	16	50	nw.
Do.	12	58	w.	Do.	22	61	w.
Do.	13	54	w.	Do.	23	60	w.
Do.	15	56	nw.	New York, N. Y.	6	72	nw.
Do.	16	70	nw.	Do.	7	54	nw.
Do.	22	72	w.	Do.	12	52	sw.
Do.	23	60	w.	Do.	16	57	nw.
Buffalo, N. Y.	1	64	w.	Do.	22	88	nw.
Do.	5	68	w.	Do.	23	54	nw.
Do.	6	64	w.	Do.	25	58	nw.
Do.	9	74	sw.	Norfolk, Va.	16	60	nw.
Do.	10	52	w.	Do.	22	74	w.
Do.	14	56	sw.	North Head, Wash.	3	96	se.
Do.	24	56	sw.	Do.	7	62	se.
Do.	25	52	w.	Do.	31	58	se.
Burlington, Vt.	27	52	s.	Point Reyes Light,			
Cheyenne, Wyo.	3	60	w.	Cal.	1	61	s.
Do.	4	56	w.	Do.	2	72	s.
Do.	14	57	w.	Do.	3	52	s.
Do.	15	64	w.	Do.	5	66	nw.
Do.	16	54	w.	Do.	6	59	nw.
Do.	18	65	w.	Do.	19	54	nw.
Do.	19	64	w.	Do.	20	58	nw.
Do.	31	52	w.	Do.	23	65	sw.
Columbus, Ohio.	8	50	w.	Do.	24	65	nw.
Eastport, Me.	16	77	ne.	Do.	25	61	nw.
El Paso, Tex.	25	52	sw.	Do.	27	56	se.
Grand Forks, N. Dak.	15	62	nw.	Providence, R. I.	6	54	w.
Hatteras, N. C.	16	53	nw.	Do.	16	54	nw.
Jacksonville, Fla.	12	54	sw.	Do.	22	71	w.
Mt. Tamalpais, Cal.	2	52	sw.	Do.	23	82	w.
Do.	3	56	sw.	St. Paul, Minn.	15	52	nw.
Do.	5	62	nw.	Do.	26	50	se.
Do.	6	57	nw.	Sandy Hook, N. J.	16	50	w.
Do.	19	72	nw.	Do.	22	65	nw.
Do.	20	74	nw.	Sault Ste. Marie,			
Do.	23	60	sw.	Mich.	5	52	nw.
Do.	24	63	sw.	Syracuse, N. Y.	6	58	nw.
Do.	25	60	nw.	Trenton, N. J.	22	54	nw.

CONDENSED CLIMATOLOGICAL SUMMARY.

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitations are based only on records from stations that have 10 or more years of observations. Of course the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, December, 1916.

Section.	Temperature.								Precipitation.					
	Section average.	Departure from the normal.	Monthly extremes.						Section average.	Departure from the normal.	Greatest monthly.		Least monthly.	
			Station.	Highest.	Date.	Station.	Lowest.	Date.			Station.	Amount.	Station.	Amount.
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	47.7	+ 1.3	3 stations	81	5	Riverton	12	16	4.41	−0.44	Robertsdale	8.78	Calera	1.45
Arizona	40.1	− 2.8	Sacaton	88	1	Flagstaff	−10	29	0.74	−0.54	Williams	2.75	Hackberry	0.09
Arkansas	42.1	− 0.1	2 stations	82	4	Dutton	−16	15	3.35	−0.50	Osceola	7.13	Whitecliffs	0.90
California	41.8	− 4.9	King City	88	21	Bridgeport	−25	27	5.81	+1.78	Deer Creek	18.52	Needles	0.00
Colorado	20.9	− 3.2	2 stations	78	4†	Dillon	−37	28	1.28	+0.10	Savage Basin	7.27	2 stations	T.
Florida	61.3	+ 1.7	2 stations	87	26†	Fenholloway	23	16	4.58	+1.96	Apalachicola	13.41	Long Key	0.02
Georgia	48.2	+ 1.2	Bainbridge	82	5	2 stations	12	19	3.53	−0.67	St. George	8.56	Putnam	1.20
Hawaii [November]	71.2	− 0.2	Mahukona	95	18	Volcano Observatory	50	9†	7.26	−0.58	Hakalan	35.30	4 stations	0.00
Idaho	21.1	− 4.3	2 stations	58	1†	Stanley	−42	27	2.44	+0.30	Elk Creek	5.84	Deer Flat	0.38
Illinois	27.9	− 2.2	6 stations	74	4†	3 stations	−16	22	2.43	+0.19	Chester	6.73	Warsaw	0.83
Indiana	28.9	− 2.0	Evansville	72	7	2 stations	−14	15	3.29	+0.54	Huntingburg	5.87	Farmersburg	1.17
Iowa	18.7	− 5.2	4 stations	67	3†	Sibley	−25	20	1.04	−0.18	Fort Madison	2.00	Alta	0.35
Kansas	28.5	− 3.5	2 stations	78	2†	Harrison	−22	21	0.65	−0.24	Pleasanton	2.00	Deerfield	T.
Kentucky	35.5	− 2.0	2 stations	74	4†	Farmers	−14	19	4.23	+0.44	Alpha	5.87	Louisa	2.49
Louisiana	53.4	+ 2.0	3 stations	88	3†	Plain Dealing	13	22	5.11	+0.37	2 stations	8.42	Minden	1.58
Maryland-Delaware	33.5	− 0.9	2 stations	76	5†	2 stations	− 3	16†	3.74	+0.05	Sudlersville, Md	5.51	Western Port, Md	0.85
Michigan	21.4	− 3.6	2 stations	61	6†	Ewen	−35	22	2.26	+0.25	Whitefish Point	4.48	Iron Mountain	0.66
Minnesota	7.9	− 7.8	2 stations	62	3†	Roseau	−44	21	0.97	+0.18	Red Lake Falls	2.40	Milaca	0.08
Mississippi	48.2	+ 1.1	2 stations	82	4†	Austin	4	15	4.70	−0.83	Pascagoula	7.79	Stoneville	2.27
Missouri	31.3	− 2.3	Hollister	82	3	Cassville	−29	15	1.85	−0.29	Cape Girardeau	7.08	Chillicothe	0.19
Montana	13.3	− 9.1	Springbrook	60	1	2 stations	−42	21†	1.12	+0.34	Adel	4.50	Renova	0.09
Nebraska	19.6	− 6.3	Syracuse	78	4	Kirkwood	−30	20	0.55	−0.19	West Point	1.98	North Loup	0.06
Nevada	27.6	− 3.1	Pahrump	70	5	San Jacinto	−30	27	0.87	−0.16	Marlette Lake	8.06	Lovelock	0.05
New England	25.9	− 0.3	Torrington, Conn	66	5	Bloomfield, Vt	−27	30†	3.37	+0.04	Portland, Me	6.09	Rutland, Vt	1.31
New Jersey	32.3	− 0.7	Indian Mills	70	5	Layton	− 8	18	4.61	+0.75	Tuckerton	6.34	Newton	3.35
New Mexico	32.4	− 1.1	2 stations	79	1†	Rociada	−23	8	0.41	−0.45	Aspen Grove Ranch	2.41	Newman	0.00
New York	26.3	0.0	Lockport No. 2	68	8	Gabriels No. 2	−28	30	2.81	−0.21	Rome	5.33	Elmira	0.97
North Carolina	41.9	− 0.1	Fayetteville	78	28	Brevard	− 4	19	2.87	−1.31	Highlands	6.33	Beaufort	1.14
North Dakota	2.5	−10.4	2 stations	61	3	Marstonmoor	−50	20	1.20	+0.69	Steele	3.29	Beach	0.17
Ohio	29.1	− 2.2	2 stations	72	4†	Peebles	−15	19	2.89	+0.11	Clarington	4.33	Green Hill	1.59
Oklahoma	38.0	− 1.2	Sac and Fox Agency	87	1	Kenton	−17	21	0.74	−0.66	Wyandotte	2.96	Ravia	0.00
Oregon	32.0	− 3.5	Toledo	66	3	Reservoir No. 3	−18	27	4.04	−0.99	Golden Falls	15.46	Harriman	0.19
Pennsylvania	29.7	− 1.1	Uniontown	73	8	Clearfield	−12	18	3.07	−0.10	Browers Lock	6.38	Wellsboro	0.59
Porto Rico	73.3	− 1.3	2 stations	92	11†	Cayey	48	18†	2.23	−2.66	Comerio Falls	6.30	4 stations	0.00
South Carolina	46.7	+ 0.3	2 stations	79	7†	Mountain Rest	11	19	2.43	−0.96	Mountain Rest	4.76	Darlington	0.84
South Dakota	11.7	− 9.4	Kennebec	70	2	Cottonwood	−41	20	0.78	+0.16	Deadwood	2.40	Eureka	0.06
Tennessee	38.9	− 0.9	2 stations	76	5†	Tazewell	−14	19	4.69	+0.09	Hohenwald	8.48	Mountain City	2.00
Texas	50.3	+ 1.5	3 stations	90	3†	Lieb (near)	−11	21	0.69	−1.93	Beaumont	6.38	37 stations	0.00
Utah	23.2	− 4.1	Springdale	78	4	Scofield	−37	28	1.71	+0.65	Pinecrest	8.09	Manila	0.05
Virginia	36.8	− 0.7	Diamond Springs	78	5	2 stations	− 6	14†	2.93	−0.42	Williamsburg	4.73	Mount Weather	1.19
Washington	28.6	− 4.9	2 stations	59	3	Deer Park	−25	26	3.83	−0.66	Cedar Lake	13.05	Starbuck	0.39
West Virginia	32.8	− 0.5	Spencer	77	6	Ryan	−18	19	3.33	−0.05	Dunlow	6.38	Upper Tract	0.85
Wisconsin	14.2	− 6.3	Beloit	63	7	Osceola No. 2	−34	21†	0.92	−0.37	Waukesha	2.34	Hayward	0.22
Wyoming	14.6	− 5.8	Painter	62	1†	Moran	−42	31	1.18	+0.20	Sundance	3.64	Lusk	0.08

† Other dates also.

DESCRIPTION OF TABLES AND CHARTS.

Table I gives the data ordinarily needed for climatological studies for about 158 Weather Bureau stations making simultaneous observations at 8 a. m. and 8 p. m., daily, 75th meridian time, and for about 41 others making only one observation. The altitudes of the instruments above ground are also given.

Table II gives a record of precipitation, the intensity of which at some period of the storm's continuance equaled or exceeded the following rates:

Duration (minutes)	5	10	15	20	25	30	35	40	45	50	60
Rates per hour (inches)	3.00	1.80	1.40	1.20	1.08	1.00	0.94	0.90	0.87	0.84	0.80

It is impracticable to make this table sufficiently wide to accommodate on one line the record of accumulated falls that continue at an excessive rate for several hours. In this case *the record is broken at the end of each 50 minutes*, the accumulated amounts being recorded on successive lines until the excessive rate ends.

In cases where no storm of sufficient intensity to entitle it to a place in the full table has occurred, the greatest precipitation of any single storm has been given, also the greatest hourly fall during that storm.

The tipping-bucket mechanism is *dismounted* and removed when there is danger of snow or water freezing in the same. Table II records this condition by entering an asterisk (*).

Table III gives, for about 30 stations of the Canadian Meteorological Service, the means of pressure and temperature, total precipitation and depth of snowfall, and the respective departures from normal values except in the case of snowfall. The sealevel pressures have been computed at Washington by the method employed for reducing United States observations and described by F. H. Bigelow in this REVIEW, January, 1902, pp. 13–16; the altitudes are those furnished us on January 1, 1916.

Chart I.—Hydrographs for several of the principal rivers of the United States.

Chart II.—Tracks of centers of HIGH areas; and

Chart III.—Tracks of centers of LOW areas. The roman numerals show the chronological order of the centers. The figures within the circles show the days of the month; the letters *a* and *p* indicate, respectively, the observations at 8 a. m. and 8 p. m., 75th meridian time. Within each circle is also given (Chart II) the last three figures of the highest barometric reading or (Chart III) the lowest reading reported at or near the center at that time, and in both cases as reduced to sealevel and standard gravity.

Chart IV.—Temperature departures. This chart presents the departures of the monthly mean temperatures from the monthly normals. The normals used in computing the departures were computed for a period of 33 years (1873 to 1905) and are published in Weather Bureau Bulletin "R," Washington, 1908. Stations whose records were too short to justify the preparation of normals in 1908 have been provided with normals as adequate records became available, and all have been reduced to the 33-year interval 1873–1905. The shaded portions of the chart indicate areas of positive departures and unshaded portions indicate areas of negative departures. Generalized lines connect places having approximately equal departures of like sign. This chart of monthly temperature departures in the United States was first published in the MONTHLY WEATHER REVIEW for July, 1909.

Chart V.—Total precipitation. The scale of shades showing the depth is given on the chart. Where the monthly amounts are too small to justify shading and over sections of the country where stations are too widely separated or the topography is too diversified to warrant reasonable accuracy in shading, the actual depths are given for a limited number of representative stations. Amounts less than 0.005 inch are indicated by the letter T, and no precipitation by 0.

Chart VI.—Percentage of clear sky between sunrise and sunset. The average cloudiness at each Weather Bureau station is determined by numerous personal observations between sunrise and sunset. The difference between the observed cloudiness and 100 is assumed to represent the percentage of clear sky, and the values thus obtained are the basis of this chart. The chart does not relate to the nighttime.

Chart VII.—Isobars and isotherms at sealevel and prevailing wind directions. The pressures have been reduced to sealevel and standard gravity by the method described by Prof. Frank H. Bigelow on pages 13–16 of the REVIEW for January, 1902. The pressures have also been reduced to the mean of the 24 hours by the application of a suitable correction to the mean of the 8 a. m. and 8 p. m. readings at stations taking two observations daily, and to the 8 a. m. or the 8 p. m. observations, respectively, at stations taking but a single observation. The diurnal corrections so applied will be found in the Annual Report of the Chief of the Weather Bureau, 1900–1901, volume 2, Table 27, pages 140–164.

The isotherms on the sealevel plane have been constructed by means of the data summarized in chapter 8 of volume 2 of the annual report just mentioned. The correction, t_0–t, or temperature on the sealevel plane minus the station temperature as given by Table 48 of that report, is added to the observed surface temperature to obtain the adopted sealevel temperature.

The prevailing wind directions are determined from hourly observations at the great majority of the stations. A few stations having no self-recording wind-direction apparatus determine the prevailing direction from the daily or twice-daily observations only.

Chart VIII.—Total snowfall. This is based on the reports from regular and cooperative observers and shows the depth in inches and tenths of the snowfall during the month. In general, the depth is shown by lines inclosing areas of equal snowfall, but in special cases figures are also given. Chart VIII is published only when the general snow cover is sufficiently extensive to justify its preparation.

Chart IX.—Average values of pressure, temperature, and prevailing wind directions, and storm tracks over the North Atlantic Ocean *for the corresponding month of last year*.

Chart X.—Presents *annually* the tracks of hurricanes of the year; tracks of the same month are all in one color. This chart was first published in the issue for September, 1916. All available reports to January 1, 1917, have been used.

Chart XI.—Presents *annually*, by means of a dot for each report, the frequency of earthquakes in the United States during the year. This chart was first published in the REVIEW for December, 1915.

TABLE I.—*Climatological data for Weather Bureau stations, December, 1916.*

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.										Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation.			Wind.					Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Barometer above sea-level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea-level, reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.					Total.	Departure from normal.	Days with 0.01 or more.	Total movement.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.						
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F*		°*F*	°*F.*		°*F*	°*F.*	°*F.*	°*F.*	°*F.*	%	*In.*	*In.*		*Miles*					*0–10*	*In.*	*In.*
New England.							28.8	−0.7											73	3.24	−0.1							5.7		
Eastport	76	67	85	29.65	29.74	−0.24	26.6	+1.3	52	1	32	− 1	30	21	27	24	18	70	3.98	0.0	16	10,991	w.	77	ne.	16	7	6	18	6.7	18.9	5.8
Greenville	1,070	6	....	28.61	29.82	.....	17.8	.....	40	6	24	− 8	30	12	27	.....	.....	.....	.....	4.87	.....	12	.....	.....	.....	.....	.....	14	1	16	....	36.1	19.0
Portland, Me	103	82	117	29.75	29.88	− .15	27.3	+0.2	49	5	33	6	31	21	19	23	17	67	6.09	+2.4	14	7,821	nw.	45	nw.	16	16	3	12	4.9	24.5	5.0
Concord	288	70	79	29.58	29.91	− .15	25.4	−1.0	48	5	32	2	30	19	20	.....	.....	.....	.....	2.21	−1.1	11	5,301	nw.	32	nw.	22	14	6	11	5.0	12.5	7.3
Burlington	404	11	48	29.48	29.95	− .10	21.6	−0.9	50	5	28	−10	30	15	30	.....	.....	.....	.....	2.79	+1.1	14	8,993	nw.	52	s.	27	5	10	16	7.2	20.2	10.0
Northfield	876	12	60	28.94	29.93	− .12	19.2	−1.3	52	5	27	−20	30	11	32	17	15	86	1.78	−0.9	16	4,819	n.	29	n.	26	4	10	17	7.5	19.1	10.0
Boston	125	115	188	29.75	29.89	− .16	32.6	+1.0	59	5	38	10	31	27	20	29	23	71	3.00	−0.4	12	9,447	w.	47	w.	23	14	7	10	4.8	9.5	T.
Nantucket	12	14	90	29.88	29.89	− .16	34.5	−2.2	55	5	40	13	31	30	19	31	26	74	3.24	−0.4	14	13,813	nw.	61	w.	22	12	8	11	5.8	5.4	....
Block Island	26	11	46	29.89	29.92	− .14	34.8	−1.8	56	5	40	16	31	30	22	31	26	73	2.84	−1.0	9	18,903	nw.	72	w.	22	14	4	13	5.6	3.9	....
Narragansett Pier	....	9	....	.....	.....	.....	29.4	−3.1	51	4	34	9	31	24	21	.....	.....	.....	.....	3.25	.....	12	.....	w.	.....	.....	.....	18	4	9	....	6.5	T.
Providence	160	215	251	29.73	29.91	− .15	31.4	−0.2	58	5	37	9	31	25	19	27	22	70	3.03	−0.8	11	12,190	nw.	82	w.	23	14	9	8	4.6	9.2	T.
Hartford	159	122	140	29.76	29.94	− .12	31.0	−1.2	57	5	36	12	31	26	19	27	21	69	2.99	−0.6	9	6,174	nw.	48	nw.	23	8	13	10	5.5	6.8	T.
New Haven	106	117	155	29.84	29.96	− .11	32.4	+0.6	58	5	38	14	18	27	18	29	24	75	3.71	+0.1	9	7,393	nw.	39	w.	22	11	12	8	5.1	8.4	....
Middle Atlantic States.							34.8	−0.4											69	3.51	+0.4							5.4		
Albany	97	102	115	29.85	29.96	−0.12	28.6	+ 1.1	54	5	34	3	30	23	21	25	20	72	2.70	+ 0.1	8	5,556	nw.	32	nw.	22	7	11	13	6.4	4.1	0.8
Binghamton	871	10	69	29.00	29.93	− .16	28.2	+ 0.5	59	5	34	5	20	22	27	.....	.....	.....	.....	1.70	− 0.7	14	4,633	nw.	32	nw.	6	2	9	20	7.5	7.1	2.0
New York	314	414	454	29.63	29.98	− .11	33.8	− 0.6	62	5	40	15	16	28	21	29	22	65	3.97	+ 0.5	12	15,335	nw.	88	nw.	22	9	12	10	5.8	13.7	....
Harrisburg	374	94	104	29.62	30.04	− .08	32.4	− 0.4	68	5	38	11	17	26	21	27	20	64	2.39	− 0.3	13	5,523	nw.	38	nw.	22	9	12	10	5.1	7.5	T.
Philadelphia	117	123	190	29.89	30.03	− .08	35.7	0.0	64	5	41	16	16	30	21	31	25	67	5.45	+ 2.4	12	8,293	nw.	48	nw.	22	11	8	12	5.5	9.2	....
Reading	325	81	98	29.66	30.03	.....	32.4	.....	67	5	38	11	17	26	19	28	22	68	4.07	+ 0.8	14	6,121	nw.	36	nw.	22	11	8	12	5.5	10.5	T.
Scranton	805	111	119	29.11	30.00	− .10	30.4	+ 0.6	61	5	36	10	20	24	22	27	22	73	3.26	+ 0.6	13	5,811	sw.	40	w.	6	4	11	16	6.8	10.7	0.3
Atlantic City	52	37	48	29.96	30.02	− .08	35.3	− 1.1	60	5	42	14	16	28	26	32	27	75	4.84	+ 1.1	13	6,428	nw.	30	w.	22	12	4	15	5.5	8.1	....
Cape May	18	13	49	30.03	30.05	− .06	36.6	− 1.4	61	5	42	16	16	31	22	34	.....	.....	.....	4.16	+ 0.4	10	8,154	nw.	35	nw.	16	11	13	7	4.9	8.4	....
Sandy Hook	22	10	57	29.99	30.01	.....	34.3	.....	60	5	39	17	16	30	18	31	26	73	4.67	.....	12	14,416	nw.	65	nw.	22	13	8	10	5.0	13.6	....
Trenton	190	159	183	29.79	30.00	.....	32.2	.....	64	5	38	12	16	26	22	28	22	70	4.87	+ 1.7	14	9,197	w.	54	nw.	22	10	9	12	5.5	10.7	T.
Baltimore	123	100	113	29.91	30.04	− .09	36.0	− 0.9	70	5	42	13	16	30	20	31	24	64	3.94	+ 0.9	12	4,876	sw.	36	sw.	22	10	12	9	5.0	10.0	....
Washington	112	62	85	29.92	30.05	− .08	35.5	− 0.6	71	5	43	13	16	28	26	30	23	65	4.03	+ 0.9	12	5,174	nw.	46	nw.	22	13	9	9	4.8	8.5	....
Lynchburg	681	153	188	29.29	30.06	− .08	38.6	+ 0.3	72	5	49	11	20	28	35	32	26	67	2.32	− 1.0	9	5,259	w.	41	nw.	22	11	12	8	5.3	5.3	....
Norfolk	91	170	205	29.96	30.06	− .07	42.7	− 0.3	68	8	51	20	16	35	29	37	32	70	3.11	− 0.4	9	10,724	sw.	74	w.	22	16	6	9	4.2	0.8	....
Richmond	144	11	52	29.90	30.07	− .07	38.8	− 2.2	72	5	48	12	20	30	35	33	27	70	3.40	+ 0.4	11	5,950	sw.	40	w.	22	15	6	10	5.0	9.1	....
Wytheville	2,293	49	55	27.62	30.09	− .06	34.2	− 1.1	65	8	45	8	20	24	40	29	24	74	2.02	− 1.7	12	5,484	w.	41	w.	22	15	16	10	4.5	9.5	....
South Atlantic States.							48.4	+ 1.3											73	2.52	− 1.1							4.6		
Asheville	2,255	70	84	27.67	30.10	−0.06	38.8	+ 1.0	66	5	49	11	19	28	35	32	26	68	1.57	− 2.5	13	7,466	nw.	40	n.	9	12	8	11	4.7	4.3	....
Charlotte	773	153	161	29.23	30.08	− .08	43.3	+ 0.4	69	8	52	18	19	35	27	37	31	69	2.32	− 1.5	13	7,816	sw.	42	sw.	13	14	5	12	4.7	0.8	....
Hatteras	11	12	50	30.06	30.07	− .06	48.6	− 0.2	69	9	56	28	31	41	28	44	40	75	2.10	− 3.0	8	11,596	w.	53	nw.	16	14	9	8	4.5	0.0	....
Manteo	12	4	46	.....	.....	.....	46.2	.....	73	28	58	19	20	35	.....	.....	.....	.....	7	3.74	− 1.4	7	.....	nw.	.....	.....	.....	18	3	10	....	0.0	....
Raleigh	376	103	110	29.67	30.08	− .07	42.7	0.0	71	8	52	20	19	34	32	37	32	71	2.25	− 0.9	11	5,902	sw.	46	sw.	22	13	11	7	4.5	0.3	....
Wilmington	78	81	91	30.00	30.09	− .06	49.4	+ 2.2	76	28	60	27	19	39	31	44	39	74	1.19	− 1.9	8	5,702	w.	38	w.	12	14	6	11	4.5	0.0	....
Charleston	48	11	92	30.04	30.09	− .06	53.0	+ 1.7	73	5	61	30	19	45	28	48	44	78	1.47	− 1.7	12	7,717	ne.	44	s.	21	16	4	11	4.5	0.0	....
Columbia, S. C	351	41	57	29.70	30.09	− .07	47.4	+ 0.2	73	8	57	26	19	38	30	39	30	59	1.40	− 1.5	13	5,397	e.	34	w.	22	16	4	11	4.2	0.0	....
Augusta	180	62	77	29.90	30.10	− .06	48.5	+ 1.5	74	8	59	26	19	38	34	43	40	82	2.12	− 1.3	13	4,118	nw.	29	nw.	12	14	7	10	4.5	0.0	....
Savannah	65	150	194	30.03	30.10	− .05	54.4	+ 3.1	78	8	63	28	19	46	27	48	43	74	2.06	− 1.0	13	9,334	sw.	44	nw.	15	12	7	12	4.8	0.0	....
Jacksonville	43	200	245	30.05	30.10	− .04	58.0	+ 2.8	79	28	67	30	19	49	30	53	50	81	7.47	+ 4.5	12	8,896	sw.	54	sw.	12	9	11	11	5.4	0.0	....
Florida Peninsula.							67.9	+ 2.0											79	0.64	− 1.4							3.3		
Key West	22	10	64	30.05	30.07	−0.01	71.7	+ 1.6	82	9	77	51	17	66	17	66	64	80	0.10	− 1.7	3	7,440	se.	28	w.	18	22	9	0	2.6	0.0	....
Miami	25	71	79	30.06	30.09	.....	69.0	+ 1.0	79	12	75	42	16	63	25	63	61	78	0.25	− 2.0	2	5,676	se.	30	w.	15	16	13	2	3.6	0.0	....
Sand Key	23	39	72	30.02	30.05	− .03	72.0	.....	77	9	74	56	16	70	11	67	65	78	0.18	.....	2	11,198	se.	44	nw.	18	25	6	0	2.2	0.0	....
Tampa	35	79	96	30.06	30.10	− .02	63.0	+ 3.5	82	27	72	38	19	54	28	57	54	80	1.60	− 0.4	6	4,405	ne.	30	nw.	12	12	11	8	4.9	0.0	....
East Gulf States.							50.7	+ 1.5											77	4.90	+ 0.4							5.6		
Atlanta	1,174	190	216	28.83	30.09	−0.07	45.0	+ 0.4	67	8	53	18	19	37	28	39	34	71	3.57	− 1.0	13	9,365	nw.	44	w.	21	13	5	13	5.2	T.	....
Macon	370	78	87	29.69	30.09	− .07	48.9	+ 2.1	76	5	60	25	19	38	35	43	38	74	2.08	− 2.3	13	4,495	s.	30	w.	18	14	8	9	4.8	0.0	....
Thomasville	273	49	58	29.79	30.09	− .06	54.6	+ 2.1	76	8	65	27	19	45	35	49	45	78	6.59	+ 2.9	16	3,280	e.	21	nw.	18	10	9	12	5.8	0.0	....
Pensacola	56	140	182	30.02	30.08	− .07	55.2	+ 1.3	72	5	62	29	19	48	32	52	48	81	9.48	+ 5.3	16	9,946	e.	45	nw.	18	11	4	16	5.8	0.0	....
Anniston	741	9	57	29.29	30.10	− .06	45.0	+ 0.8	72	6	56	17	19	34	35	.....	.....	.....	.....	3.31	− 1.2	11	5,310	se.	27	w.	21	16	3	12	5.0	T.	....
Birmingham	700	11	48	29.32	30.10	− .06	46.8	− 0.5	71	6	56	21	19	37	31	41	36	69	3.70	− 0.9	8	6,188	s.	29	se.	20	11	5	15	5.7	T.	....
Mobile	57	125	161	30.00	30.06	− .09	53.9	+ 2.4	77	5	61	31	22	46	32	50	47	81	6.68	+ 2.1	13	7,423	se.	41	nw.	18	10	3	18	6.3	0.0	....
Montgomery	223	100	112	29.84	30.10	− .06	50.5	+ 1.4	74	4	60	26	19	41	31	45	41	74	3.89	− 0.6	13	5,157	se.	36	nw.	18	10	9	12	5.5	0.0	....
Corinth	469	6	....	.....	.....	.....	41.0	.....	74	5	53	12	16	30	40	.....	.....	.....	.....	7.74	.....	13	.....	s.	.....	.....	.....	9	15	7	....	3.8	....
Jackson	304	5	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
Meridian	375	85	93	29.66	30.07	− .09	49.2	+ 2.3	74	4	58	24	23	40	33	45	41	79	3.71	− 1.5	10	4,635	s.	29	w.	18	8	5	18	6.4	0.0	....
Vicksburg	247	65	74	29.79	30.07	− .08	50.8	+ 1.4	77	4	60	20	22	41	32	46	43	80	3.70	− 1.3	8	6,409	se.	26	nw.	18	10	8	13	5.6	0.0	....
New Orleans	51	76	84	30.00	30.06	− .07	57.4	+ 3.0	80	20	66	32	15	49	33	53	51	85	7.17	+ 2.7	11	5,249	se.	30	e.	25	10	5	16	6.0	0.0	....
West Gulf States.							49.8	+ 1.2											69	1.13	− 1.7							4.9		
Shreveport	249	77	93	29.77	30.05	−0.08	49.8	+ 0.9	78	4	60	15	22	40	35	44	39	72	1.65	− 2.7	7	6,231	s.	28	s.	26	14	7	10	4.6	0.0	....
Bentonville	1,303	11	44	28.60	30.00	− .13	35.9	− 1.6	70	3	47	− 8	22	25	45	.....	.....	.....	.....	2.41	− 0.4	8	5,646	s.	26	s.	19	16	3	12	4.5	11.8	....
Fort Smith	457	79	94	29.52	30.02	− .11	39.4	+ 2.3	73	3	49	1	15	29	38	34	28	67	2.16	− 0.7	6	7,109	e.	36	sw.	11	15	3	13	4.9	8.3	....
Little Rock	357	139	147	29.66	30.05	− .09	43.4	− 0.1	76	4	53	11	15	34	36	38	32	69	2.17	− 2.1	8	7,858	sw.	34	sw.	4	9	8	14	5.7	3.2	....
Brownsville	57	3	40	.....	.....	.....	65.3	.....	85	20	76	33	22	55	38	.....	.....	.....	.....	0.69	.....	2	.....	n.	.....	.....	.....	.....	.....	.....	.....	0.0	....
Corpus Christi	20	69	77	30.00	30.02	− .10	59.9	+ 3.3	83	28	68	30	22	52	35	55	51	80	0.77	− 0.6	4	8,223	se.	37	ne.	14	4	15	12	6.4	0.0	....
Dallas	512	109	117	29.47	30.03	.....	47.7	.....	80	3	59	14	22	36	38	.....	.....	.....	.....	0.08	.....	3	7,821	e.	39	se.	19	13	8	10	4.7	T.	....
Fort Worth	670	106	114	29.28	30.00	− .12	48.0	+ 0.5	82	3	60	13	22	36	40	39	29	54	0.11	− 1.1	2	8,334	nw.	40	s.	19	14	8	9	4.5	T.	....
Galveston	54	106	114	29.98	30.04	− .08	57.7	+ 1.4	77	20	64	26	22	51	33	54	50	80	0.79	− 2.9	8	9.350	s.	43	n.	14	8	9	14	5.9	0.0	....
Houston	138	111	121	29.88	30.04	.....	56.8	+ 2.3	82	5	67	23	22	47	41	.....	.....	.....	.....	3.68	.....	9	6,664	s.	33	s.	7	11	10	10	5.0	0.0	....
Palestine	510	64	72	29.48	30.02	− .10	51.4	+ 2.0	80	4	61	14	22	42	37	44	39	70	0.74	− 2.9	4	6,564	sw.	30	s.	19	15	6	10	4.6	0.0	....
San Antonio	701	119	132	29.28	30.02	− .09	54.6	+ 1.5	81	20	66	22	22	43	47	46	38	62	0.33	− 1.2	4	6,037	ne.	42	n.	8	18	7	6	3.6	0.0	....
Taylor	582	55	63	29.43	30.06	− .05	51.2	+ 0.6	80	4	63	18	22	39	40	.....	.....	.....	.....	0.19	− 2.4	3	7,260	sw.	38	sw.	19	11	12	8	4.8	0.0	....

TABLE I.—*Climatological data for Weather Bureau stations, December, 1916*—Continued.

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.												Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation.			Wind.						Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Barometer above sea-level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sealevel, reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.						Total.	Departure from normal.	Days with 0.01 or more.	Total movement.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.							
Ohio Valley and Tennessee.	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F		°F	°F.		°F.	°F.	°F.	°F.	°F.			%	*In.*	*In.*		*Miles*									*0–10*	*In.*	*In*
							34.8	− 1.8													73	3.45	0.0										5.7		
Chattanooga	762	189	213	29.28	30.11	−0.05	41.5	− 1.1	72	5	50	16	19	34	31	36	30	65	4.22	− 0.1	11	6,553	ne.	36	sw.	13	13	6	12	5.1	2.3	....
Knoxville	996	93	100	29.00	30.09	− .07	39.0	− 0.7	68	5	48	9	19	30	29	34	28	71	3.63	− 0.5	10	3,604	ne.	29	w.	13	11	9	11	5.2	9.3	....
Memphis	399	76	97	29.65	30.08	− .07	43.4	− 0.1	74	4	52	10	15	35	33	38	32	67	3.26	− 1.1	8	7,869	s.	33	nw.	13	15	7	9	4.6	5.5	....
Nashville	546	168	191	29.49	30.09	− .06	38.8	− 2.3	67	5	48	2	19	29	37	34	29	70	4.29	+ 0.5	10	8,208	w.	41	se.	26	13	8	10	5.1	10.0	....
Lexington	989	193	230	28.98	30.09	− .05	34.0	− 2.4	66	7	42	2	16	26	39	....	....	....	3.63	+ 0.3	16	11,782	sw.	44	w.	8	12	7	12	5.4	12.5	....
Louisville	525	219	255	29.49	30.09	− .05	34.8	− 3.3	69	7	43	2	15	27	36	31	25	70	4.12	+ 0.4	15	10,048	sw.	40	s.	4	10	9	12	5.7	9.7	....
Evansville	431	139	175	29.57	30.06	− .07	35.2	− 1.2	72	7	44	2	15	27	34	31	27	74	4.66	+ 0.8	13	9,817	sw.	36	sw.	13	12	11	8	5.0	12.9	....
Indianapolis	822	194	230	29.12	30.04	− .08	29.5	− 3.1	62	7	38	− 2	15	22	37	26	22	75	2.50	− 0.5	12	9,889	s.	44	w.	15	9	6	16	6.3	9.9	....
Terre Haute	575	96	129	29.39	30.03	.....	30.6	.....	68	7	39	− 3	22	22	36	27	22	76	2.39	.....	13	8,149	nw.	40	nw.	15	5	16	10	6.4	7.9	....
Cincinnati	628	11	51	29.36	30.06	− .07	31.6	− 2.8	63	4	40	1	15	23	38	28	24	76	3.60	+ 0.7	13	6,687	sw.	31	sw.	9	11	7	13	6.2	8.0	....
Columbus	824	173	222	29.14	30.05	− .07	30.4	− 2.4	63	8	38	0	16	22	34	27	23	77	3.59	+ 0.8	15	9,462	sw.	50	w.	8	13	6	12	5.4	13.5	T.
Dayton	899	181	216	29.04	30.03	.....	29.9	− 3.2	61	4	38	0	15	22	37	27	23	75	2.16	− 0.5	14	8,293	sw.	43	w.	16	10	7	14	6.0	6.9	T.
Pittsburgh	842	353	410	29.11	30.04	− .07	32.9	− 1.8	70	8	41	1	16	25	37	28	23	73	2.01	− 0.7	13	9,385	w.	48	w.	9	6	6	19	6.9	5.8	....
Elkins	1,940	41	50	27.95	30.09	− .03	32.4	− 0.1	70	8	44	1	16	20	41	27	22	76	3.20	− 0.2	13	3,450	w.	33	w.	9	7	8	16	6.6	16.4	....
Parkersburg	638	77	84	29.40	30.08	− .06	34.2	− 1.0	69	8	44	3	16	25	36	29	25	75	3.48	+ 0.7	15	4,600	se.	34	nw.	22	9	8	14	5.9	5.4	....
Lower Lake Region.							27.1	− 2.0													74	2.54	− 0.4										7.4		
Buffalo	767	247	280	29.10	29.96	−0.10	28.4	− 1.7	66	8	35	6	16	22	33	26	23	83	3.37	0.0	18	15,062	w.	74	sw.	9	1	9	21	8.0	28.8	7.0
Canton	448	10	61	29.44	29.94	.....	18.6	− 4.1	54	9	27	−21	30	10	38	....	....	....	2.53	− 1.1	13	8,018	w.	43	w.	9	6	4	21	7.5	23.5	8.7
Oswego	335	76	91	29.58	29.96	− .10	27.9	− 1.3	56	5	34	3	31	22	23	26	22	79	1.91	− 1.7	16	9,814	s.	44	nw.	6	1	5	25	8.6	25.7	11.0
Rochester	523	97	113	29.38	29.98	− .08	28.2	− 0.7	65	8	34	8	16	22	31	25	20	73	3.09	+ 0.2	22	7,889	w.	38	w.	6	3	7	21	7.8	24.9	10.0
Syracuse	597	97	113	29.31	29.97	− .10	27.2	− 0.9	59	5	34	6	31	21	28	25	21	76	2.86	+ 0.2	18	9,633	w.	38	nw.	6	3	7	21	7.8	19.8	4.5
Erie	714	130	166	29.18	29.97	− .10	30.2	− 1.5	67	8	36	10	16	24	32	27	23	76	2.87	− 0.2	19	13,444	sw.	49	se.	27	2	2	27	8.3	20.3	2.7
Cleveland	762	190	201	29.16	30.01	− .08	29.0	− 2.1	63	8	36	2	16	22	36	26	21	74	2.06	− 0.5	19	11,688	sw.	49	ne.	22	4	9	18	7.2	12.3	0.3
Sandusky	629	62	103	29.30	30.01	− .08	28.2	− 2.9	63	8	35	0	16	21	25	25	21	77	2.09	− 0.3	18	10,716	sw.	43	sw.	9	10	8	13	6.2	7.6	T.
Toledo	628	208	243	29.30	30.01	− .07	27.6	− 2.9	59	4	35	− 1	15	20	26	25	21	78	2.42	+ 0.1	17	11,353	sw.	46	w.	24	11	5	15	6.1	9.1	0.2
Fort Wayne	856	113	124	29.07	30.03	.....	26.2	− 1.1	61	4	34	− 3	15	18	29	23	19	77	2.81	.....	17	8,017	sw.	33	sw.	9	5	12	14	6.2	9.0	T.
Detroit	730	218	245	29.17	29.98	− .09	26.9	− 2.6	56	8	33	− 1	15	20	30	24	21	82	2.24	− 0.2	17	10,102	w.	41	sw.	9	6	6	19	7.2	11.3	1.5
Upper Lake Region.							20.3	− 4.1													82	2.16	+ 0.1										6.4		
Alpena	609	13	92	29.24	29.93	−0.09	22.2	− 2.6	48	5	29	− 3	15	15	25	20	18	87	2.24	0.0	13	9,438	w.	44	se.	26	5	11	15	6.9	14.9	4.2
Escanaba	612	54	60	29.24	29.94	− .09	17.4	− 4.2	45	8	25	−10	22	10	32	15	12	78	1.38	− 0.3	11	7,062	nw.	33	se.	26	16	5	10	4.6	7.4	4.5
Grand Haven	632	54	92	29.25	29.96	− .09	25.8	− 4.3	57	8	31	2	15	20	26	24	20	78	2.78	+ 0.3	17	10,228	w.	48	w.	5	6	5	20	7.2	21.4	4.3
Grand Rapids	707	70	87	29.18	29.97	− .08	25.4	− 3.4	59	4	31	1	15	20	23	23	20	80	3.81	+ 1.3	19	5,114	w.	38	nw.	5	7	2	22	7.8	23.1	4.5
Houghton	684	62	99	29.15	29.91	− .11	16.6	− 4.3	46	3	24	−16	19	10	32	....	....	....	2.29	− 0.2	19	7,666	e.	26	e.	6	7	18	7.2	21.6	16.0
Lansing	878	11	62	28.99	29.97	.....	22.7	− 4.1	59	4	31	− 7	15	14	26	21	18	87	2.11	0.0	17	4,612	w.	22	w.	5	8	2	21	7.2	11.6	3.0
Ludington	637	60	66	29.22	29.94	.....	25.0	.....	55	7	30	5	15	20	24	23	20	83	3.48	.....	20	9,126	w.	38	w.	5	6	2	23	7.4	36.2	8.0
Marquette	734	77	111	29.11	29.94	− .08	18.6	− 4.3	48	4	26	− 9	15	12	32	16	13	82	3.09	+ 0.6	11	9,460	w.	46	e.	19	10	7	14	6.1	30.8	12.4
Port Huron	638	70	120	29.25	29.97	− .09	24.8	− 2.5	58	8	32	− 2	18	17	32	22	20	85	1.35	− 0.8	16	9,215	w.	40	w.	5	7	12	12	6.2	7.9	2.8
Saginaw	641	48	82	29.24	29.96	.....	22.9	.....	57	4	30	− 3	19	16	24	21	19	88	2.10	+ 0.2	15	7,551	w.	34	sw.	5	5	8	18	7.3	7.5	3.4
Sault Ste. Marie	614	11	61	29.20	29.93	− .07	18.4	− 2.1	43	3	25	− 2	14	12	28	18	14	82	3.31	+ 1.0	20	7,810	se.	52	nw.	5	5	5	21	7.6	25.9	10.6
Chicago	823	140	310	29.08	30.00	− .08	26.0	− 3.3	64	7	33	− 2	22	19	33	23	18	70	2.58	+ 0.5	13	9,778	nw.	35	w.	24	15	5	11	4.9	7.1	0.4
Green Bay	617	109	144	29.26	29.95	− .09	16.4	− 4.9	50	7	24	−15	22	9	31	14	9	75	1.04	− 0.8	8	8,894	sw.	37	w.	5	13	6	12	5.6	8.5	3.8
Milwaukee	681	119	133	29.21	29.97	− .09	21.0	− 5.0	58	7	28	− 9	22	14	32	18	16	84	1.81	− 0.1	12	8,429	w.	45	se.	26	16	5	10	4.6	7.9	2.5
Duluth	1,133	11	47	28.68	29.97	− .08	8.8	− 8.9	45	3	17	−23	18	1	25	6	4	86	0.38	− 0.8	7	12,090	w.	48	nw.	15	13	8	10	5.0	2.9	1.2
North Dakota.							2.8	− 9.0													85	1.27	+ 0.6										4.7		
Moorhead	940	8	57	28.94	30.02	−0.06	4.4	− 6.3	53	4	14	−31	21	− 6	41	2	− 2	80	1.17	+ 0.4	11	6,332	s.	36	nw.	14	17	9	5	3.5	11.7	11.1
Bismarck	1,674	8	57	28.16	30.06	− .02	3.6	−11.4	60	3	15	−42	20	− 8	46	2	0	88	1.52	+ 0.9	11	7,025	nw.	40	nw.	14	12	11	8	4.7	21.7	15.5
Devils Lake	1,482	11	44	28.30	29.98	− .08	0.8	− 7.2	54	3	10	−37	19	− 9	41	− 1	− 3	86	0.90	+ 0.5	9	8,116	w.	44	n.	14	12	7	12	5.3	15.9	9.9
Grand Forks	835	12	89	.....	.....	.....	0.6	.....	52	4	12	−34	19	−11	46	− 2	....	....	1.66	.....	9	.....	nw.	62	nw.	15	16	9	6	.....	16.9	6.6
Williston	1,872	41	48	27.93	30.03	− .03	2.6	−11.0	52	3	12	−33	20	− 7	41	2	− 1	85	1.50	+ 0.8	6	5,580	sw.	34	nw.	14	12	9	10	5.3	14.1	9.8
Upper Mississippi Valley.							23.2	− 4.1													76	1.46	− 0.3										5.2		
Minneapolis	918	10	208	28.94	29.97	.....	12.4	.....	55	4	20	−24	21	4	31	....	....	....	0.98	0.0	10	8,450	w.	42	nw.	15	11	6	14	5.6	13.6	8.2
St. Paul	837	201	236	29.03	29.98	−0.10	12.2	− 7.1	53	4	21	−24	21	4	31	....	....	....	1.21	+ 0.2	10	9,217	nw.	52	nw.	15	12	9	10	5.0	11.7	8.5
La Crosse	714	11	48	29.17	29.98	− .10	14.9	− 7.9	57	7	24	−21	21	6	33	....	....	....	1.20	− 0.1	9	3,987	w.	30	sw.	27	12	7	12	5.4	16.1	7.8
Madison	974	70	78	28.90	30.01	− .07	18.0	− 4.7	60	7	26	−14	21	10	30	15	11	76	1.24	− 0.5	10	7,263	w.	28	se.	26	11	5	15	5.7	10.1	6.2
Wausau	1,247	4	....	28.55	29.95	.....	13.4	.....	53	4	22	−16	18	5	33	....	....	....	1.15	.....	11	.....	nw.	.....	.....	.....	.....	.....	.....	4.7	8.9	5.2
Charles City	1,015	10	49	28.88	30.01	− .09	14.6	− 4.4	54	7	25	−21	21	4	39	12	9	84	1.11	− 0.2	7	5,660	nw.	25	se.	26	11	11	9	4.8	11.0	5.7
Davenport	606	71	79	29.33	30.02	− .08	22.3	− 4.9	66	7	31	−11	22	14	31	20	16	79	1.44	− 0.2	13	5,915	nw.	32	nw.	15	11	10	10	5.3	8.0	2.6
Des Moines	861	84	97	29.05	30.00	− .11	22.0	− 3.7	62	4	32	−14	21	12	33	18	13	70	0.65	− 0.7	6	5,207	nw.	24	nw.	16	11	7	13	5.3	7.9	3.8
Dubuque	698	81	96	29.25	30.04	− .06	19.3	− 5.2	61	7	28	−15	21	11	30	16	12	76	0.95	− 0.8	10	4,946	nw.	26	nw.	15	14	4	13	5.3	6.0	3.1
Keokuk	614	64	78	29.33	30.04	− .08	26.0	− 3.4	67	7	35	−10	21	17	35	23	18	75	0.73	− 1.1	7	6,054	nw.	33	w.	15	9	15	7	4.7	2.6	....
Cairo	356	87	93	29.65	30.05	− .10	37.7	− 0.8	74	4	46	3	15	29	31	33	29	73	4.46	+ 1.1	9	7,521	n.	34	se.	26	13	9	9	4.8	3.3	....
Peoria	609	11	45	29.34	30.03	− .08	25.2	− 2.9	67	4	34	−11	22	16	38	22	19	83	1.75	− 0.6	9	6,116	w.	32	w.	15	11	10	10	5.2	3.9	T.
Springfield, Ill	644	10	91	29.32	30.02	− .10	28.6	− 2.7	68	4	36	− 3	22	21	35	25	20	72	1.22	− 1.2	10	7,195	nw.	32	nw.	15	8	11	12	5.9	1.7	T.
Hannibal	534	74	109	29.43	30.02	− .10	27.9	− 3.4	66	7	37	− 6	21	19	35	....	....	....	1.59	− 0.1	9	7,155	sw.	33	nw.	15	9	12	10	5.3	3.3	....
St. Louis	567	265	303	29.40	30.02	− .11	33.6	− 1.9	71	4	42	2	15	26	36	29	24	71	2.16	− 0.1	8	10,815	s.	42	s.	7	12	7	12	5.2	2.5	....
Missouri Valley.							22.4	− 4.5													74	0.90	− 0.2										4.8		
Columbia, Mo	781	11	84	29.15	30.02	−0.10	29.8	− 3.1	66	7	38	0	22	21	33	....	....	....	1.66	− 0.4	9	6,856	se.	30	w.	15	9	9	13	5.8	1.9	....
Kansas City	963	161	181	28.94	30.01	− .11	29.9	− 1.6	66	4	39	− 3	21	21	32	26	20	68	0.34	− 1.0	9	9,267	nw.	37	nw.	15	13	10	8	4.5	0.9	....
St. Joseph	967	11	49	28.94	30.01	.....	27.0	.....	66	4	37	− 9	21	17	32	24	18	71	0.48	.....	7	6,942	nw.	31	nw.	12	12	12	7	4.8	0.6	T.
Springfield, Mo	1,324	9[illegible]	104	28.58	30.02	− .11	32.2	− 2.3	74	3	42	− 6	22	24	34	29	25	75	2.07	− 0.6	10	9,261	se.	37	w.	12	12	16	5	10	4.5	16.7	....
Iola	9[illegible]4	11	50	28.93	30.02	− .07	30.2	− 2.3	69	4	41	− 1	14	20	35	....	....	....	0.68	− 0.2	6	6,017	s.	25	nw.	12	13	10	8	4.4	2.5	....
Topeka	987	85	101	.....	.....	.....	28.6	− 2.5	70	4	39	− 6	21	19	31	....	....	....	0.70	− 0.2	7	7,471	nw.	35	nw.	12	14	11	6	4.3	1.9	T.
Drexel	1,299	10	53	28.57	30.02	.....	19.1	.....	62	3	31	−20	21	8	35	16	12	80	0.66	.....	7	8,404	nw.	38	se.	25	15	8	8	4.3	6.1	2.3
Lincoln	1,189	11	84	28.70	30.02	− .10	22.2	− 4.7	66	4	33	−15	21	11	36	18	12	67	0.48	− 0.2	8	7,838	n.	44	nw.	16	15	10	6	4.2	4.9	0.7
Omaha	1,105	115	122	28.79	30.02	− .09	22.2	− 4.9	64	4	32	−14	21	12	35	19	13	69	0.65	− 0.3	7	6,603	nw.	32	nw.	7	16	6	9	4.3	5.8	1.5
Valentine	2,598	47	54	27.18	30.03	− .07	14.8	− 9.7	63	2	28	−29	20	2	44	11	8	83	0.50	− 0.1	10	7,147	w.	38	s.	6	14	9	8	4.5	5.4	3.3
Sioux City	1,135	94	164	28.74	30.02	− .10	17.2	− 5.4	59	4	28	−16	20	7	40	15	10	77	1.50	+ 0.8	8	9,365	nw.	46	nw.	16	13	10	8	4.6	16.3	8.0
Huron	1,306	59	74	28.57	30.04	− .06	11.0	− 4.7	61	3	23	−26	20	− 1	46	8	2	74	1.14	+ 0.5	8	8,421	nw.	42	nw.	14	8	12	11	5.9	8.6	5.8
Pierre	1,572	70	75	28.29	30.05	− .05	12.5	− 7.6	66	2	24	−24	20	1	44	9	4	72	0.61	+ 0.1	9	6,841	nw.	45	nw.	26	13	7	11	5.3	11.7	3.1
Yankton	1,233	49	57	28.64	30.02	− .09	16.7	− 5.5	64	3	27	−20	20	6	42	....	....	....	0.49	− 0.2	8	6,303	nw.	32	nw.	16	11	8	12	5.5	5.8	1.2

TABLE I.—*Climatological data for Weather Bureau stations, December, 1916*—Continued.

Districts and stations.	Elevation of instruments. Barometer above sea-level.	Elevation of instruments. Thermometer above ground.	Elevation of instruments. Anemometer above ground.	Pressure. Station, reduced to mean of 24 hours.	Pressure. Sealevel, reduced to mean of 24 hours.	Pressure. Departure from normal.	Temperature of the air. Mean max.+mean min.÷2.	Temperature of the air. Departure from normal.	Temperature of the air. Maximum.	Temperature of the air. Date.	Temperature of the air. Mean maximum.	Temperature of the air. Minimum.	Temperature of the air. Date.	Temperature of the air. Mean minimum.	Temperature of the air. Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation. Total.	Precipitation. Departure from normal.	Precipitation. Days with 0.01 or more.	Wind. Total movement.	Wind. Prevailing direction.	Wind. Maximum velocity. Miles per hour.	Wind. Maximum velocity. Direction.	Wind. Maximum velocity. Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*° F.*	*° F.*	*° F*		*° F*	*° F.*		*° F*	*° F.*	*° F.*	*° F.*	*%*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
Northern Slope.							**14.3**	**− 9.4**										**74**	**1.24**	**+ 0.4**										**5.9**		
Billings	3,140	5	....	.....	.....	.....	15.0	.....	56	2	25	−15	28	5	43	....	....	....	0.49	.....	8	.....	sw.	....	.....	.....	12	13	6	.....	.....	.....
Havre	2,505	11	44	27.26	30.04	−0.01	7.0	−14.2	53	2	17	−33	28	−3	45	7	5	86	1.05	+ 0.4	10	6,321	sw.	34	w.	15	8	9	14	6.0	10.7	10.2
Helena	4,110	87	114	25.66	30.02	− .11	17.0	− 7.8	51	1	24	−20	27	10	31	14	9	72	1.03	+ 0.2	12	5,404	sw.	38	w.	14	6	13	12	6.0	14.5	3.2
Kalispell	2,962	11	34	26.85	30.05	− .02	14.9	− 9.0	45	3	22	−20	26	7	25	14	12	84	1.70	− 0.2	19	2,759	w.	30	sw.	4	2	9	20	7.5	16.3	10.3
Miles City	2,371	26	48	27.40	30.09	− .01	10.0	−11.0	58	3	20	−28	28	0	38	7	2	75	1.99	+ 1.4	15	4,493	se.	27	sw.	4	8	7	6	4.9	19.2	11.7
Rapid City	3,259	50	58	26.46	30.06	− .03	15.2	−10.8	60	3	26	−28	20	4	42	11	3	62	0.75	+ 0.3	9	6,010	w.	44	n.	12	9	12	10	5.6	7.9	2.4
Cheyenne	6,088	84	101	23.78	29.95	− .14	21.0	− 8.0	50	2	31	−11	26	11	32	17	10	63	0.34	0.0	9	13,594	w.	65	w.	18	15	6	10	4.4	5.2	T.
Lander	5,372	60	68	24.46	30.05	− .10	12.2	− 7.0	48	1	25	−21	27	0	47	9	3	67	1.37	+ 0.7	8	3,107	sw.	44	w.	22	8	14	9	5.5	14.6	5.4
Sheridan	3,790	10	47	25.95	30.02	.....	14.6	.....	53	3	26	−17	28	4	40	12	8	82	1.07	.....	12	4,432	nw.	38	nw.	6	6	9	16	7.0	15.7	6.6
Yellowstone Park	6,200	11	48	23.68	30.05	− .11	12.2	− 9.4	45	1	21	−14	26	4	28	11	7	78	2.47	+ 0.6	15	5,840	s.	34	s.	3	4	8	19	7.5	33.9	26.2
North Platte	2,821	11	51	26.99	30.06	− .04	19.4	− 7.2	66	2	33	−17	21	6	42	14	9	75	0.42	0.0	8	5,272	w.	32	n.	7	14	8	9	4.6	4.4	1.6
Middle Slope.							**29.9**	**− 3.0**										**66**	**0.67**	**− 0.1**										**4.3**		
Denver	5,292	106	113	24.54	29.95	−0.13	26.5	− 5.7	65	6	38	− 5	27	14	42	21	12	58	1.09	+ 0.5	8	6,078	se.	35	n.	17	14	9	8	4.6	16.3	1.0
Pueblo	4,685	80	86	25.13	29.92	− .16	29.8	− 1.9	68	6	45	− 2	21	15	47	23	12	54	0.23	− 0.2	4	6,416	nw.	42	w.	19	24	5	2	3.0	5.3	....
Concordia	1,392	50	58	28.49	30.02	− .09	25.6	− 3.9	69	4	37	−14	21	14	39	21	17	77	0.88	+ 0.4	6	6,065	nw.	36	nw.	12	8	12	11	5.8	8.8	1.6
Dodge City	2,509	11	51	27.30	30.00	− .10	29.0	− 2.6	73	2	44	− 6	21	14	52	22	17	72	0.30	− 0.3	6	7,148	n.	33	s.	6	16	10	5	3.7	3.0	T.
Wichita	1,358	139	158	28.51	29.99	− .12	31.0	− 3.2	68	4	42	− 4	21	20	37	27	21	70	0.46	− 0.3	5	10,312	s.	42	nw.	12	13	10	8	4.7	1.2	....
Altus	1,410	5	....	.....	.....	.....	40.0	.....	82	2	54	6	22	26	45	....	....	....	0.13	.....	2	.....	n.	....	.....	....	24	1	6	....	1.0	....
Muskogee	652	4	....	.....	.....	.....	36.1	.....	72	5	47	− 4	22	25	49	....	....	....	0.87	.....	5	.....	n.	....	.....	....	20	2	9	....	5.0	....
Oklahoma	1,214	10	47	28.69	30.01	− .10	37.6	− 1.0	77	3	49	2	21	26	38	31	25	67	1.05	− 0.7	4	11,469	s.	45	s.	10	18	9	4	3.8	6.5	....
Southern Slope.							**43.5**	**− 1.0**										**51**	**0.33**	**− 0.5**										**3.3**		
Abilene	1,738	10	52	28.16	30.00	−0.11	46.5	− 1.5	81	2	60	15	21	33	40	35	22	45	0.02	− 1.1	1	8,159	s.	35	sw.	22	20	5	6	3.4	0.2	....
Amarillo	3,676	10	49	26.16	29.98	− .11	36.6	+ 0.2	73	4	50	0	21	23	40	28	20	63	0.88	0.0	7	9,145	sw.	40	sw.	23	24	7	0	3.1	6.3	....
Del Rio	944	64	71	29.02	30.02	− .08	51.5	− 0.9	81	17	64	22	9	39	49	....	....	....	0.06	− 0.8	4	6,016	e.	40	nw.	8	20	5	6	3.5	0.0	....
Roswell	3,566	75	85	26.30	29.98	− .09	39.3	− 1.9	75	2	56	11	21	23	45	29	15	45	0.36	− 0.2	2	5,868	sw.	48	sw.	25	20	7	4	3.1	T.	....
Southern Plateau.							**38.4**	**− 3.7**										**50**	**0.71**	**0.0**										**2.9**		
El Paso	3,762	110	133	26.16	29.98	−0.05	45.0	+ 0.2	71	2	57	17	9	32	33	34	17	37	0.32	− 0.2	2	8,149	nw.	52	sw.	25	19	10	2	2.7	T.	....
Santa Fe	7,013	57	66	23.11	30.00	− .06	27.9	− 2.4	58	5	38	2	8	18	28	22	14	60	0.17	− 0.6	5	6,110	n.	46	sw.	25	12	14	5	4.7	5.4	T.
Flagstaff	6,908	8	57	23.25	29.98	− .08	25.8	− 2.6	59	5	40	−10	29	12	50	20	....	....	1.11	.....	5	.....	w.	45	w.	23	16	9	6	....	17.5	9.0
Phoenix	1,108	76	81	28.85	30.03	− .01	47.1	− 4.8	78	1	62	24	9	33	44	38	29	56	0.39	− 0.2	2	3,449	e.	34	sw.	25	22	5	4	2.3	T.	....
Yuma	141	9	54	29.88	30.04	− .01	50.6	− 5.1	77	5	64	30	9	38	40	40	26	45	0.73	+ 0.3	2	4,336	n.	27	n.	7	25	4	2	1.8	0.0	....
Independence	3,910	11	42	25.97	30.04	− .08	34.1	− 7.5	72	12	49	− 2	27	19	46	....	....	....	1.92	+ 1.1	3	.....	sw.	....	.....	....	17	7	7	....	25.0	1.0
Middle Plateau.							**26.8**	**− 4.5**										**68**	**0.89**	**− 0.1**										**5.4**		
Reno	4,532	74	81	25.44	30.08	−0.07	31.2	− 2.5	56	19	42	4	25	20	36	26	20	66	0.97	− 0.7	10	5,141	w.	44	se.	2	12	11	8	4.8	12.5	4.8
Tonopah	6,090	12	20	24.00	30.08	.....	28.2	.....	48	1	35	6	26	22	24	24	17	64	0.52	− 0.3	2	8,034	se.	44	nw.	19	12	9	10	4.7	4.0	0.7
Winnemucca	4,344	18	56	25.59	30.10	− .08	26.6	− 4.1	57	5	40	− 8	27	13	41	21	15	68	0.26	− 0.7	6	6,080	sw.	48	sw.	24	8	10	13	6.2	3.7	1.9
Modena	5,479	10	43	24.55	30.06	− .06	23.4	− 8.3	56	1	37	−24	27	10	41	18	11	65	0.67	+ 0.1	3	8,162	w.	45	s.	24	16	11	4	3.8	10.1	5.4
Salt Lake City	4,360	147	189	25.57	30.05	− .10	27.8	− 4.3	57	5	35	2	28	21	28	24	19	70	2.64	+ 1.3	15	5,531	se.	42	nw.	6	5	8	18	7.3	31.7	12.0
Grand Junction	4,602	82	96	25.34	30.01	− .09	24.8	− 3.4	55	6	35	0	28	14	34	21	16	74	0.27	− 0.2	8	4,292	nw.	38	w.	23	9	14	8	5.4	5.8	....
Northern Plateau.							**26.4**	**− 5.6**										**79**	**1.75**	**0.0**										**7.8**		
Baker	3,471	48	53	26.39	30.07	−0.09	22.6	− 4.8	45	1	30	−10	27	15	25	21	17	78	1.12	− 0.4	14	4,767	se.	34	sw.	5	7	7	17	6.8	11.9	4.5
Boise	2,739	78	86	27.16	30.11	− .09	28.4	− 3.8	53	2	35	3	31	22	25	26	20	70	1.29	− 0.4	14	3,678	nw.	26	se.	5	6	8	17	7.2	10.8	2.2
Lewiston	757	40	48	29.23	30.07	− .06	30.2	− 7.3	53	3	36	4	29	24	20	....	....	....	1.59	+ 0.1	14	2,096	e.	26	w.	3	2	8	21	8.0	9.0	1.0
Pocatello	4,477	60	68	25.38	30.04	− .15	23.4	− 5.0	51	1	30	− 7	30	17	31	21	18	78	2.31	+ 1.4	16	9,033	se.	40	sw.	19	2	9	20	7.8	19.7	15.0
Spokane	1,929	101	110	27.93	30.05	− .03	23.6	− 7.2	46	3	29	− 8	26	18	19	23	20	83	1.49	− 1.1	15	3,483	sw.	28	sw.	3	1	7	23	8.3	13.2	8.2
Walla Walla	991	57	65	28.96	30.06	− .06	30.5	− 5.5	57	3	36	5	29	25	22	28	26	85	2.68	+ 0.6	17	3,356	s.	31	w.	3	0	7	24	8.7	13.8	4.7
North Pacific Coast Region.							**38.8**	**− 3.4**										**87**	**5.49**	**− 2.2**										**8.6**		
North Head	211	11	56	29.74	29.98	−0.05	40.4	− 3.9	48	3	44	31	29	37	10	39	38	93	6.38	− 1.1	25	11,551	e.	96	se.	3	1	4	26	8.8	2.4	....
North Yakima	1,071	4	....	.....	.....	.....	26.3	.....	51	3	34	0	29	19	26	....	....	....	0.74	.....	8	.....	nw.	....	.....	....	3	7	21	....	12.0	5.5
Port Angeles	42	8	48	29.95	29.98	.....	36.8	.....	49	18	41	26	1	33	13	....	....	....	4.94	− 0.2	18	3,641	se.	27	sw.	4	0	2	29	9.2	2.0	T.
Seattle	125	215	250	29.88	30.01	.00	38.0	− 3.2	51	2	42	27	29	34	13	36	34	84	4.13	− 1.9	20	6,469	se.	44	s.	3	1	3	27	9.0	3.7	....
Tacoma	213	113	120	29.77	30.01	.00	37.8	− 2.5	51	2	42	22	29	34	14	37	35	89	3.65	− 3.7	18	4,061	sw.	30	sw.	3	0	4	27	9.1	1.5	....
Tatoosh Island	109	7	57	29.83	29.93	− .03	39.6	− 4.3	48	3	42	32	28	37	10	38	37	90	11.67	− 2.9	25	13,214	e.	78	s.	3	2	6	23	8.4	1.2	....
Medford	1,425	4	....	.....	.....	.....	32.6	.....	58	1	39	9	30	26	27	....	....	....	1.71	.....	16	.....	e.	....	.....	....	1	2	28	....	9.6	4.6
Portland, Oreg.	153	68	106	29.87	30.03	− .04	38.1	−23.2	51	2	42	24	30	34	12	36	33	81	3.81	− 3.5	16	4,845	se.	28	sw.	3	0	7	24	8.5	1.6	0.8
Roseburg	510	9	57	29.51	30.07	− .04	39.0	− .9	53	2	44	28	16	34	15	37	35	87	3.88	− 2.0	17	2,308	s.	36	sw.	5	1	15	15	7.4	2.2	....
Middle Pacific Coast Region.							**45.0**	**− 3.6**										**78**	**4.41**	**0.0**										**5.1**		
Eureka	62	73	89	30.02	30.09	−0.03	43.2	− 4.8	59	1	49	31	8	37	22	42	41	90	5.47	− 1.8	17	4,509	se.	40	w.	23	6	9	16	6.4	T.	....
Mount Tamalpais	2,375	11	18	27.56	30.07	− .05	42.2	− 5.4	61	15	47	28	26	38	16	37	31	71	5.42	+ 1.5	15	17,155	nw.	74	nw.	20	12	5	14	5.5	2.3	....
Point Reyes Light	490	7	18	29.51	30.03	.....	46.9	− 3.7	62	15	51	35	26	42	17	....	....	....	2.97	.....	12	14,388	nw.	72	s.	2	15	5	11	5.1	0.0	....
Red Bluff	332	50	56	29.70	30.07	− .07	44.1	− 2.3	67	13	53	27	30	36	37	39	34	71	3.56	− 0.9	9	4,420	nw.	27	se.	23	17	5	9	4.4	5.8	....
Sacramento	69	106	117	30.01	30.09	− .05	44.2	− 2.1	62	4	52	30	13	36	26	42	38	81	3.73	+ 0.2	11	6,110	se.	39	se.	2	13	8	10	5.2	0.0	....
San Francisco	155	209	213	29.91	30.08	− .04	48.9	− 2.0	62	16	55	37	28	43	19	45	40	75	4.79	+ 0.6	15	5,502	n.	43	sw.	23	16	4	11	4.2	.....	....
San Jose	141	12	110	29.94	30.09	.....	45.2	− 4.7	63	16	55	28	8	35	33	....	....	....	3.48	+ 0.4	13	4,540	w.	36	se.	2	14	3	14	5.3	0.0	....
South Pacific Coast Region.							**50.0**	**− 3.0**										**72**	**4.00**	**+ 1.8**										**4.6**		
Fresno	327	89	98	29.74	30.11	−0.02	45.4	− 1.4	71	4	55	28	7	36	31	41	37	75	1.93	+ 0.4	9	4,096	nw.	40	nw.	24	13	8	10	4.8	0.1	....
Los Angeles	338	159	191	29.69	30.06	− .01	52.6	− 3.9	79	14	61	36	27	44	33	45	37	64	3.67	+ 0.8	9	4,763	ne.	42	s.	24	15	5	11	4.7	T.	....
San Diego	87	62	70	29.95	30.05	− .02	52.4	− 3.3	76	14	60	38	17	45	34	47	43	75	1.14	− 0.7	6	4,244	nw.	40	w.	25	14	7	10	4.5	0.0	....
San Luis Obispo	201	32	40	29.88	30.10	− .01	49.6	− 3.2	73	15	60	29	18	39	41	44	39	72	9.26	+ 6.9	11	3,025	n.	22	n.	10	16	6	9	4.7	0.0	....
West Indies.																																
San Juan, P. R	82	8	54	29.93	30.02	+0.05	74.8	.....	82	19	80	65	17	70	15	....	....	....	1.69	− 4.5	15	11,353	ne.	41	ne.	28	10	18	3	4.4	0.0	....
Panama Canal.																																
Balboa Heights	118	7	97	29.72	29.84	.....	79.1	.....	89	5	86	70	11	72	18	74	73	91	5.86	+1.39	14	4,609	nw.	21	n.	24	2	24	5	5.9	0.0	....
Colon	36	5	85	29.81	29.85	.....	79.8	.....	88	12	84	72	10	75	13	75	74	84	5.71	−6.20	17	9,481	nw.	33	nw.	29	9	15	7	5.8	0.0	....

TABLE II.—*Accumulated amounts or precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during December, 1916, at all stations furnished with self-registering gages.*

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time indicated.												
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Abilene, Tex	7			0.02														0.02			
Albany, N. Y	9			0.47														0.28			
Alpena, Mich	8–9			0.75														*			
Amarillo, Tex	30–31			0.31														*			
Anniston, Ala	28			0.92														0.55			
Asheville, N. C	28			0.43														0.27			
Atlanta, Ga	8	2:30 p. m.	7:10 p. m.	1.27	5:41 p. m.	6:16 p. m.	0.33	0.11	0.27	0.37	0.44	0.52	0.69	0.76							
Atlantic City, N. J	21			0.84														0.32			
Augusta, Ga	18			0.55														0.26			
Baker, Oreg	24			0.38														*			
Baltimore, Md	22			1.26														0.44			
Bentonville, Ark	7			0.95														0.40			
Binghamton, N. Y	22			0.78														0.14			
Birmingham, Ala	28	5:42 a. m.	7:55 a. m.	1.29	5:49 a. m.	6:20 a. m.	0.01	0.11	0.19	0.28	0.55	0.76	0.80	0.89							
Bismarck, N. Dak	26			0.63														*			
Block Island, R. I	22			0.87														0.33			
Boise, Idaho	20–21			0.27														*			
Boston, Mass	22			0.83														0.41			
Buffalo, N. Y	21–22			1.13														*			
Burlington, Vt	22			1.43														*			
Cairo, Ill	8			1.10														0.56			
Canton, N. Y	22			0.88														*			
Charles City, Iowa	25–26			0.55														*			
Charleston, S. C	12			0.30														0.25			
Charlotte, N. C	12			0.78														0.21			
Chattanooga, Tenn	28			1.22														0.53			
Cheyenne, Wyo	19–20			0.09														*			
Chicago, Ill	7–8			0.94														*			
Cincinnati, Ohio	4			0.83														0.37			
Cleveland, Ohio	26–27			0.39														*			
Columbia, Mo	7			1.13														0.55			
Columbia, S. C	18			0.34														0.24			
Columbus, Ohio	4			1.26														0.50			
Concord, N. H	22			0.86														*			
Concordia, Kans	31			0.28														*			
Corpus Christi, Tex	30			0.73														0.25			
Dallas, Tex	31			0.06														0.01			
Davenport, Iowa	26			0.43														*			
Dayton, Ohio	26–27			0.74														*			
Del Rio, Tex	31			0.02														0.02			
Denver, Colo	17			0.29														*			
Des Moines, Iowa	19			0.22														*			
Detroit, Mich	26–27			0.67														*			
Devils Lake, N. Dak	26–27			0.44														*			
Dodge City, Kans	31			0.10														*			
Dubuque, Iowa	24			0.33														*			
Duluth, Minn	6–7			0.09														*			
Eastport, Me	15–16			1.68														*			
Elkins, W. Va	22			0.44														0.18			
El Paso, Tex	30			0.28														0.11			
Erie, Pa	21–22			0.57														*			
Escanaba, Mich	26–27			0.42														*			
Eureka, Cal	22			0.71														0.31			
Evansville, Ind	26			1.38														0.44			
Flagstaff, Ariz	24–25			0.72														*			
Fort Smith, Ark	26			0.66														0.52			
Fort Wayne, Ind	26–27			1.28														*			
Fort Worth, Tex	31			0.09														0.04			
Fresno, Cal	24			0.29														0.12			
Galveston, Tex	8			0.29														0.28			
Grand Haven, Mich	7			0.33														0.19			
Grand Junction, Colo	6–7			0.14														*			
Grand Rapids, Mich	7			0.39														0.24			
Green Bay, Wis	24			0.29														*			
Hannibal, Mo	7–8			0.80														*			
Harrisburg, Pa	22			0.74														0.24			
Hartford, Conn	22			1.03														0.44			
Hatteras, N. C	18			0.79														0.30			
Havre, Mont	24–25			0.28														*			
Helena, Mont	5–6			0.26														*			
Houghton, Mich	13–14			0.44														*			
Houston, Tex	25	12:28 a. m.	8:20 a. m.	2.02	4:03 a. m.	4:46 a. m.	0.50	0.06	0.14	0.24	0.32	0.44	0.58	0.81	0.97	1.00					
Huron, S. Dak	25–26			0.53														*			
Independence, Cal	23–24			1.91														*			
Indianapolis, Ind	26–27			0.49														*			
Iola, Kans	26			0.33														*			
Jacksonville, Fla	21–22	D. N. a. m.	D. N. a. m.	4.71	9:02 a. m.	9:20 a. m.	1.74	0.24	0.41	0.46	0.51										
					11:24 a. m.	12:24 p. m.	2.41	0.08	0.18	0.40	0.44	0.44	0.50	0.54	*	*	*	1.25			
					1:38 p. m.	1:56 p. m.	3.72	0.12	0.36	0.50	0.56										
Kalispell, Mont	5–6			0.43														*			
Kansas City, Mo	25–26			0.18														*			
Keokuk, Iowa	26			0.35														*			
Key West, Fla	18			0.06														0.06			
Knoxville, Tenn	28			1.26														0.58			
La Crosse, Wis	26			0.34														*			
Lander, Wyo	13			0.44														*			
Lansing, Mich	8–9			0.86														*			
Lewiston, Idaho	18			0.15														0.07			
Lexington, Ky	4			0.80														0.40			
Lincoln, Nebr	31			0.22														*			
Little Rock, Ark	26			0.90														0.22			
Los Angeles, Cal	24			2.36														0.34			
Louisville, Ky	26			1.31														0.45			
Ludington, Mich	7			0.56														0.32			
Lynchburg, Va	22			0.82														0.47			
Macon, Ga	28			0.54														0.39			
Madison, Wis	24			0.53														*			
Marquette, Mich	11			0.59														*			
Memphis, Tenn	26			1.11														0.66			

* Self-register not working.

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.08 in 1 hour, during December, 1916, at all stations furnished with self-registering gages*—Continued.

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time indicated.													
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Meridian, Miss.	27–28	7:45 p. m.	7:50 a. m.	1.60	5:02 a. m.	5:46 a. m.	0.24	0.20	0.36	0.40	0.52	0.78	0.94	1.02	1.21	1.31	.....	.....	.....	.....	.....
Miami, Fla.	18	.....	.....	0.22	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.16	.....	.....	.....
Milwaukee, Wis.	7–8	.....	.....	0.60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Minneapolis, Minn.	26	.....	.....	0.38	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Mobile, Ala.	14–15	10:00 a. m.	D. N. a. m.	1.93	2:47 p. m.	4:06 p. m.	0.46	0.08	0.13	0.15	0.27	0.53	0.68	0.75	0.84	0.92	0.98	1.04	1.34	.....	.....
Modena, Utah.	24–25	.....	.....	0.61	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Montgomery, Ala.	17	.....	.....	0.87	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.58	.....	.....	.....
Moorhead, Minn.	25–26	.....	.....	0.52	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Mount Tamalpais, Cal.	28	.....	.....	0.48	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.29	.....	.....	.....
Nantucket, Mass.	22	.....	.....	1.02	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.45	.....	.....	.....
Nashville, Tenn.	27	.....	.....	1.85	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.48	.....	.....	.....
New Haven, Conn.	22	.....	.....	1.32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.49	.....	.....	.....
New Orleans, La.	14	12:15 p. m.	4:05 p. m.	0.93	12:32 p. m.	12:40 p. m.	0.01	0.34	0.58	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	24	7:55 a. m.	10:15 a. m.	0.68	8:11 a. m.	8:31 a. m.	0.03	0.24	0.40	0.44	0.56	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	25–26	2:10 p. m.	D. N. a. m.	2.66	3:19 p. m.	3:56 p. m.	0.15	0.14	0.28	0.78	1.30	1.68	1.96	2.09	2.12	.....	.....	.....	.....	.....	.....
New York, N. Y.	22	.....	.....	0.81	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.25	.....	.....	.....
Norfolk, Va.	28	.....	.....	0.63	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.34	.....	.....	.....
Northfield, Vt.	22–23	.....	.....	0.80	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
North Head, Wash.	3	.....	.....	0.99	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.28	.....	.....	.....
North Platte, Nebr.	17	.....	.....	0.14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Oklahoma, Okla.	26	.....	.....	0.32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.32	.....	.....	.....
Omaha, Nebr.	31	.....	.....	0.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Oswego, N. Y.	4–5	.....	.....	0.55	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Palestine, Tex.	7	.....	.....	0.39	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.31	.....	.....	.....
Parkersburg, W. Va.	27	.....	.....	1.23	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.31	.....	.....	.....
Pensacola, Fla.	7	10:15 a. m.	5:45 p. m.	2.48	3:05 p. m.	3:20 p. m.	1.14	0.31	0.83	1.04	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	20	3:50 a. m.	10:05 a. m.	2.60	8:14 a. m.	8:40 a. m.	1.33	0.08	0.39	0.63	0.94	1.03	1.08	.....	.....	.....	.....	.....	.....	.....	.....
	24	3:15 p. m.	8:50 p. m.	0.84	4:40 p. m.	4:52 p. m.	0.16	0.24	0.42	0.47	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Peoria, Ill.	7	.....	.....	0.42	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.30	.....	.....	.....
Philadelphia, Pa.	22	.....	.....	1.76	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.47	.....	.....	.....
Phoenix, Ariz.	25	.....	.....	0.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.14	.....	.....	.....
Pierre, S. Dak.	25–26	.....	.....	0.32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Pittsburgh, Pa.	27	.....	.....	0.68	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.19	.....	.....	.....
Pocatello, Idaho.	5	.....	.....	0.35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.25	.....	.....	.....
Point Reyes Light, Cal.	2	.....	.....	0.90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.33	.....	.....	.....
Port Angeles, Wash.	3	.....	.....	1.03	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.20	.....	.....	.....
Port Huron, Mich.	8–9	.....	.....	0.34	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Portland, Me.	22	.....	.....	1.40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.47	.....	.....	.....
Portland, Oreg.	5	.....	.....	0.68	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.17	.....	.....	.....
Providence, R. I.	15–16	.....	.....	0.91	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Pueblo, Colo.	7	.....	.....	0.10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Raleigh, N. C.	12	.....	.....	0.86	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.28	.....	.....	.....
Rapid City, S. Dak.	18–19	.....	.....	0.29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Reading, Pa.	22	.....	.....	1.35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.34	.....	.....	.....
Red Bluff, Cal.	5	12 noon..	12:15 p. m.	0.40	12 noon...	12:14 p. m.	0.00	0.05	0.23	0.40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Reno, Nev.	24	.....	.....	0.29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Richmond, Va.	11–12	.....	.....	1.28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Rochester, N. Y.	21–22	.....	.....	1.56	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Roseburg, Oreg.	3	.....	.....	0.35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.11	.....	.....	.....
Roswell, N. Mex.	30–31	.....	.....	0.36	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Sacramento, Cal.	2	.....	.....	1.19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.20	.....	.....	.....
Saginaw, Mich.	4	.....	.....	0.22	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.21	.....	.....	.....
St. Joseph, Mo.	26	.....	.....	0.27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.24	.....	.....	.....
St. Louis, Mo.	26	.....	.....	1.06	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
St. Paul, Minn.	26	.....	.....	0.53	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Salt Lake City, Utah.	25–26	.....	.....	0.60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
San Antonio, Tex.	30	.....	.....	0.29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.08	.....	.....	.....
San Diego, Cal.	24	.....	.....	0.71	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.30	.....	.....	.....
Sand Key, Fla.	10	.....	.....	0.17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.16	.....	.....	.....
Sandusky, Ohio.	26–27	.....	.....	0.59	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Sandy Hook, N. J.	22	.....	.....	1.01	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.36	.....	.....	.....
San Francisco, Cal.	1–2	.....	.....	1.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
San Jose, Cal.	23	.....	.....	0.84	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.32	.....	.....	.....
San Luis Obispo, Cal.	24	.....	.....	2.95	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.11	.....	.....	.....
Santa Fe, N. Mex.	10–11	.....	.....	0.09	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Sault Ste. Marie, Mich.	8–9	.....	.....	0.81	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Savannah, Ga.	12	.....	.....	0.36	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.32	.....	.....	.....
Scranton, Pa.	22	.....	.....	1.09	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Seattle, Wash.	11–12	.....	.....	0.74	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Sheridan, Wyo.	11–12	.....	.....	0.47	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Shreveport, La.	8	.....	.....	0.44	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.43	.....	.....	.....
Sioux City, Iowa.	31	.....	.....	0.54	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Spokane, Wash.	21	.....	.....	0.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Springfield, Ill.	7	.....	.....	0.42	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.18	.....	.....	.....
Springfield, Mo.	7–8	.....	.....	0.68	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Syracuse, N. Y.	22	.....	.....	0.73	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Tacoma, Wash.	3	.....	.....	0.49	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.13	.....	.....	.....
Tampa, Fla.	15	6:35 a. m.	8:58 a. m.	0.63	6:48 a. m.	7:06 a. m.	0.01	0.18	0.29	0.40	0.48	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Tatoosh Island, Wash.	4	.....	.....	0.45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.27	.....	.....	.....
Taylor, Tex.	30	.....	.....	0.15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.09	.....	.....	.....
Terre Haute, Ind.	26–27	.....	.....	0.91	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.38	.....	.....	.....
Thomasville, Ga.	8	3:42 p. m.	5:35 p. m.	1.30	4:40 p. m.	5:25 p. m.	0.10	0.15	0.22	0.39	0.47	0.65	0.85	0.94	1.03	1.19	.....	.....	.....	.....	.....
Toledo, Ohio.	4	.....	.....	0.19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.12	.....	.....	.....
Tonopah, Nev.	24	.....	.....	0.42	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Topeka, Kans.	26	.....	.....	0.46	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.41	.....	.....	.....
Trenton, N. J.	22	.....	.....	1.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Valentine, Nebr.	25–26	.....	.....	0.23	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Vicksburg, Miss.	27	D. N. a. m.	7:10 a. m.	2.12	3:49 a. m.	4:32 a. m.	0.21	0.36	0.51	0.71	0.85	0.88	0.94	1.20	1.53	1.68	.....	.....	.....	.....	.....
Walla Walla, Wash.	11–12	.....	.....	0.63	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Washington, D. C.	22	.....	.....	1.23	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Wausau, Wis.	24	.....	.....	0.23	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Wichita, Kans.	26	.....	.....	0.34	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Williston, N. Dak.	25–26	.....	.....	0.64	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Wilmington, N. C.	12	.....	.....	0.39	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.19	.....	.....	.....
Winnemucca, Nev.	24	.....	.....	0.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Wytheville, Va.	28	.....	.....	0.57	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.22	.....	.....	.....
Yankton, S. Dak.	23–24	.....	.....	0.32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....
Yellowstone Park, Wyo.	24–25	.....	.....	0.63	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*	.....	.....	.....

* Self-register not working. † Record partly estimated. ‡ No precipitation occurred during the month.

TABLE III.—*Data furnished by the Canadian Meteorological Service, December, 1916.*

Stations.	Barometer above M. S. L.* Jan. 1, 1916.	Pressure.			Temperature.						Precipitation.		
		Station, reduced to mean of 24 hours.	Sealevel, reduced to mean of 24 hours.	Departure from normal.	Mean max.+ mean min.÷2.	Departure from normal.	Mean maximum.	Mean minimum.	Highest.	Lowest.	Total.	Departure from normal.	Total snowfall.
	Feet.	*Inches.*	*Inches.*	*Inches.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*Inches.*	*Inches.*	*Inches.*
St. Johns, N. F.	125	29.39	29.53	−0.30	34.7	+ 6.0	39.2	30.2	54	8	5.65	+0.62	6.0
Sydney, C. B. I.	48	29.59	29.63	− .26	33.3	+ 5.1	39.2	27.4	55	6	9.26	+4.63	12.0
Halifax, N. S.	88	29.57	29.68	− .28	31.3	+ 3.7	38.0	24.6	56	6	6.16	+1.04	5.5
Yarmouth, N. S.	65	29.65	29.72	− .26	32.1	+ 1.4	37.3	27.0	53	11	5.87	+0.83	9.9
Charlottetown, P. E. I.	38	29.60	29.64	− .30	29.3	+ 5.0	33.7	25.0	46	4	4.41	+0.75	10.5
Chatham, N. B.	28	29.68	29.70	− .24	25.2	+ 8.2	31.1	19.2	48	− 9	7.10	+3.88	26.4
Father Point, Que.	20	29.79	29.82	− .13	20.2	+ 4.8	25.1	15.3	38	− 6	6.75	+3.92	60.4
Quebec, Que.	296	29.53	29.86	− .15	17.5	+ 2.3	23.2	11.9	39	−12	2.01	−1.68	15.5
Montreal, Que.	187	29.71	29.93	− .10	20.0	+ 1.7	25.2	14.8	48	− 6	3.18	−0.47	19.4
Stonecliffe, Ont.	489	29.32	29.95	− .06	16.3	+ 1.3	25.8	6.8	40	−22	1.64	−0.85	8.8
Ottawa, Ont.	236	29.67	30.05	+ .03	17.4	+ 0.4	24.4	10.4	48	−20	2.91	0.00	22.8
Kingston, Ont.	285	29.64	29.98	− .06	22.8	− 0.9	30.1	15.5	48	− 4	3.03	−0.21	23.9
Toronto, Ont.	379	29.54	29.97	− .08	26.9	− 0.1	33.1	20.8	55	5	2.03	−0.88	12.6
White River, Ont.	1,244	28.50	29.88	− .09	2.2	− 7.5	14.7	−10.1	41	−46	1.61	−0.10	15.1
Port Stanley, Ont.	592	29.32	29.98	− .09	25.1	− 3.3	32.9	17.3	50	−16	2.45	+0.03	13.1
Southampton, Ont.	656	29.20			25.7	− 1.0	32.0	19.4	55	4	4.55	+0.57	33.9
Parry Sound, Ont.	688	29.21	29.94	− .07	20.8	− 0.4	28.1	13.5	48	− 8	5.94	+1.46	36.8
Port Arthur, Ont.	644	29.20	29.94	− .05	8.2	− 5.0	17.3	− 0.9	41	−23	0.76	−0.11	7.6
Winnipeg, Man.	760	29.11	30.00	− .02	1.3	− 2.8	8.3	− 5.6	46	−31	1.70	+0.79	17.0
Minnedosa, Man.	1,690	28.04	29.96	− .06	0.1	− 5.6	9.3	− 9.0	42	−36	0.30	−0.32	3.0
Qu'Appelle, Sask.	2,115	27.56	29.95	− .05	0.5	− 6.9	9.9	− 8.9	46	−39	0.92	+0.40	9.2
Medicine Hat, Alberta.	2,144	27.57	29.96	− .01	9.4	− 8.8	19.2	− 0.4	52	−35	1.25	+0.70	12.5
Swift Current, Sask.	2,392	27.25	29.98	− .01	4.3	−11.7	12.5	− 4.0	42	−35	1.10	+0.32	11.0
Calgary, Alberta.	3,428	26.24	29.93	− .01	13.2	− 5.0	23.6	2.8	50	−25	0.50	−0.09	5.0
Banff, Alberta.	4,521												
Edmonton, Alberta.	2,150	27.52	29.93	.00	5.0	− 8.1	14.1	− 4.1	43	−37	1.74	+1.04	17.4
Prince Albert, Sask.	1,450	28.34	29.99	− .02	− 1.2	− 4.0	7.2	− 9.6	44	−32	0.26	−0.48	2.6
Battleford, Sask.	1,592	28.15	30.00	+ .01	1.9	− 3.5	10.9	− 7.1	45	−30	0.22	−0.10	2.2
Kamloops, B. C.	1,262	28.74	30.09	+ .15	18.5	−10.4	24.0	12.9	46	−13	1.06	+0.28	10.6
Victoria, B. C.	230	29.71	29.97	.00	37.3	− 3.9	40.4	34.2	49	27	4.92	−3.06	1.4
Barkerville, B. C.	4,180	25.48	29.94	+ .06	11.3	− 9.6	18.9	3.8	34	−23	2.50	−0.67	25.0
Hamilton, Bermuda.	151	29.92	30.09	− .03	62.9	− 1.8	67.7	58.1	72	49	2.54	−1.95	0.0

* See description of Table III given on p. 706—C. A. jr.

Chart I. Hydrographs of Several Principal Rivers, December, 1916.

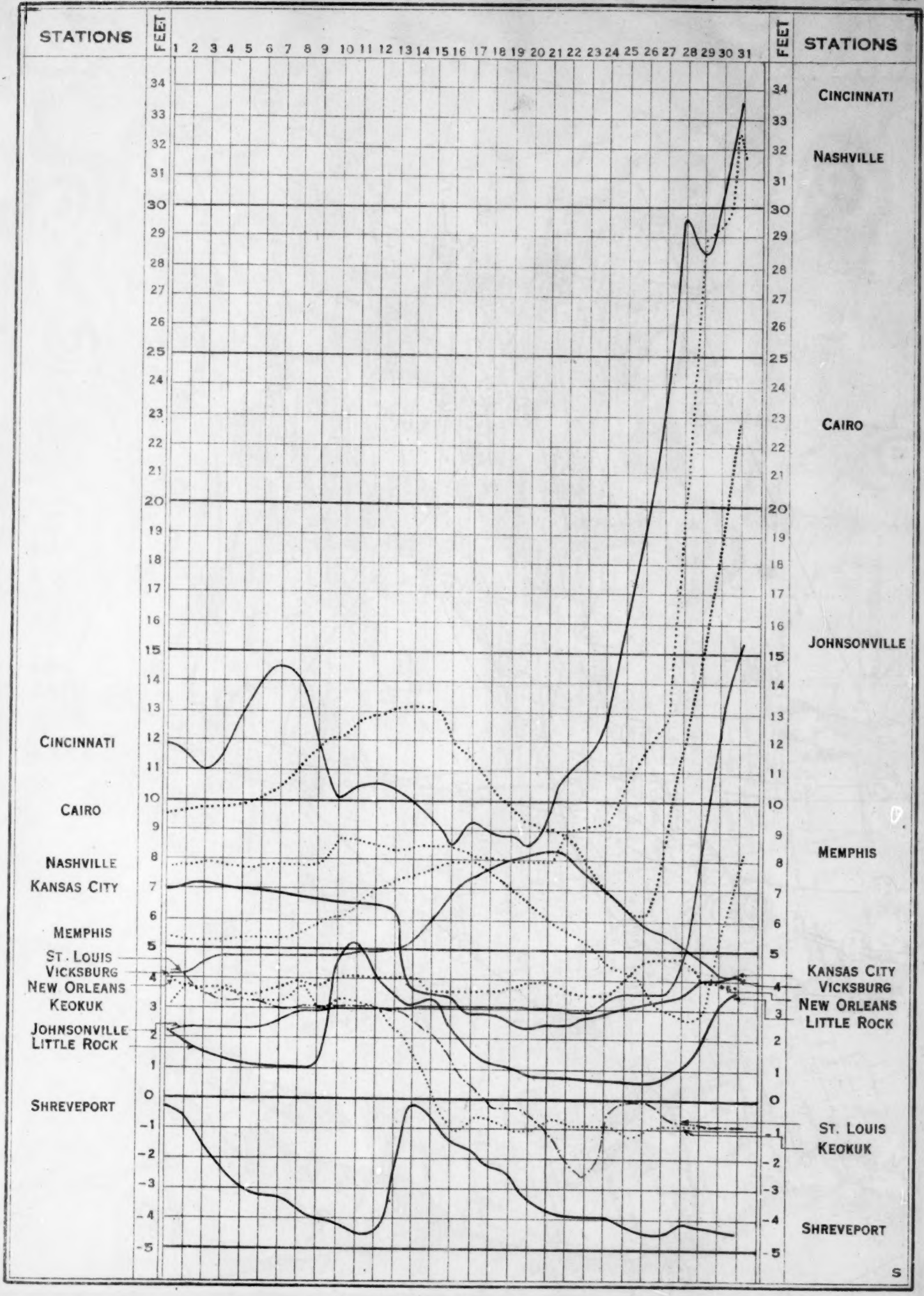

Chart II. Tracks of Centers of High Areas, December, 1916.

(Plotted by Charles A. Donnel.)

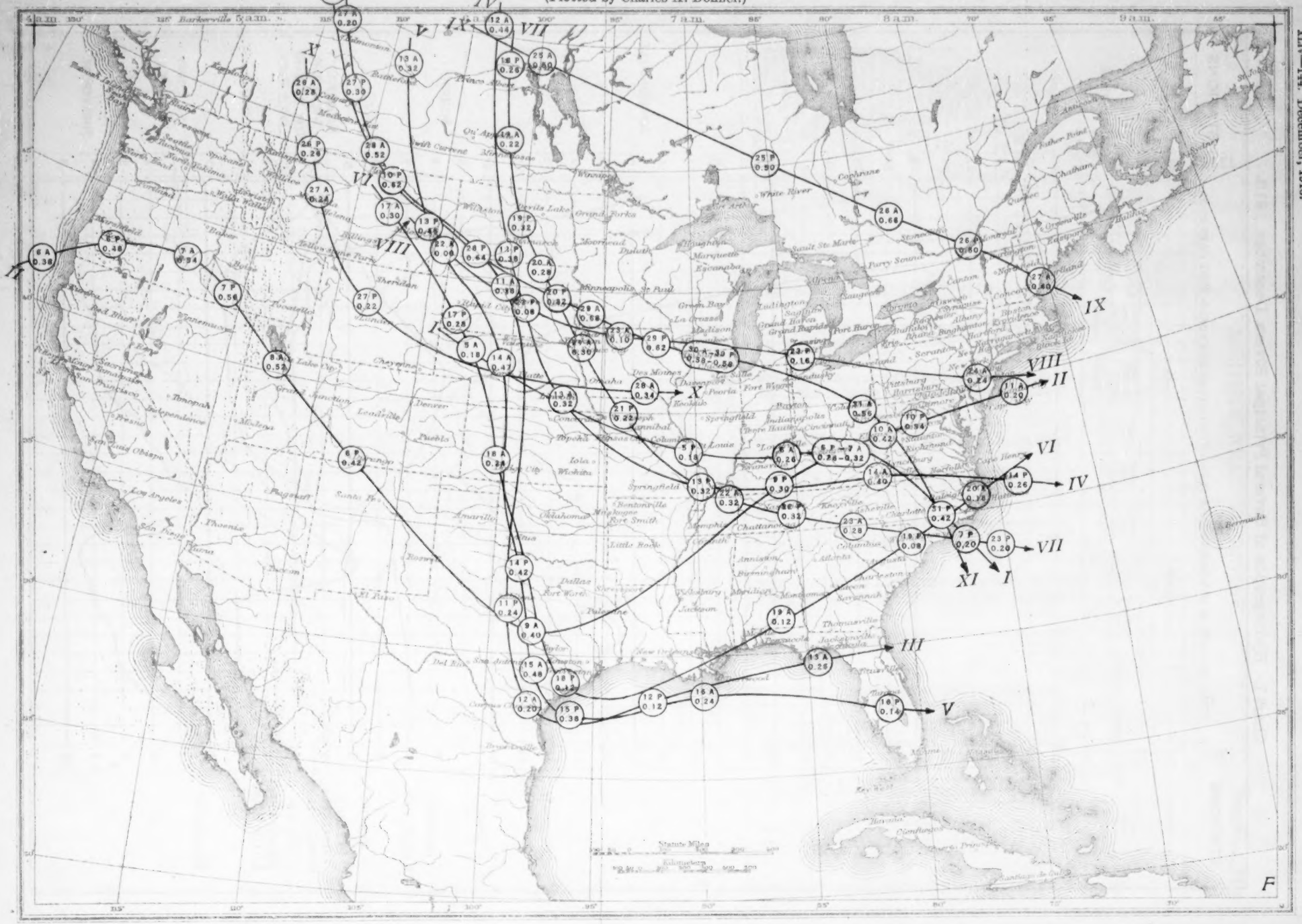

Chart III. Tracks of Centers of Low Areas, December, 1916.

(Plotted by Charles A. Donnel.)

Chart III. Tracks of Centers of Low Areas, December, 1916.

(Plotted by Charles A. Donnel.)

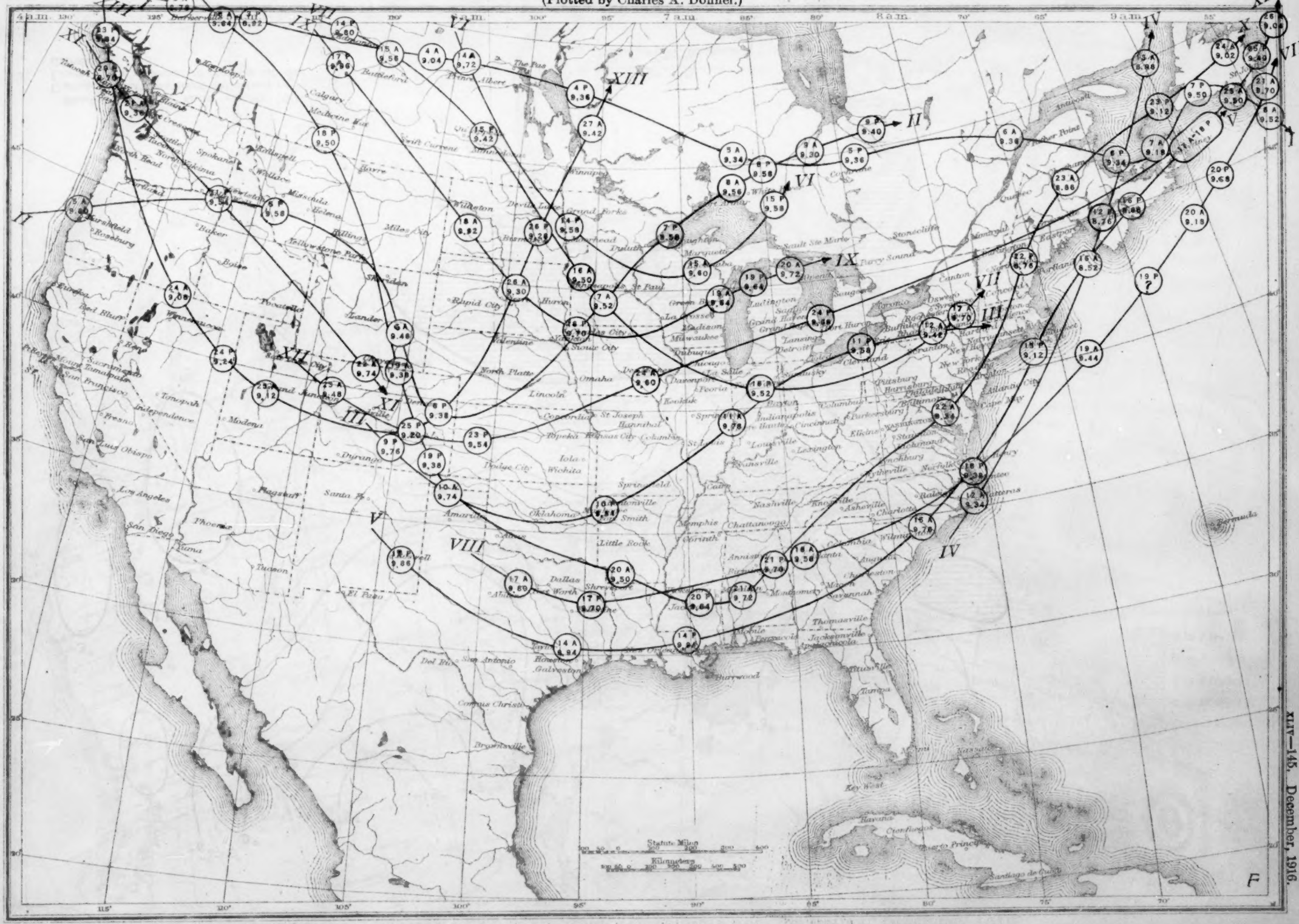

Chart IV. Departure (°F.) of the Mean Temperature from the Normal, December, 1916.

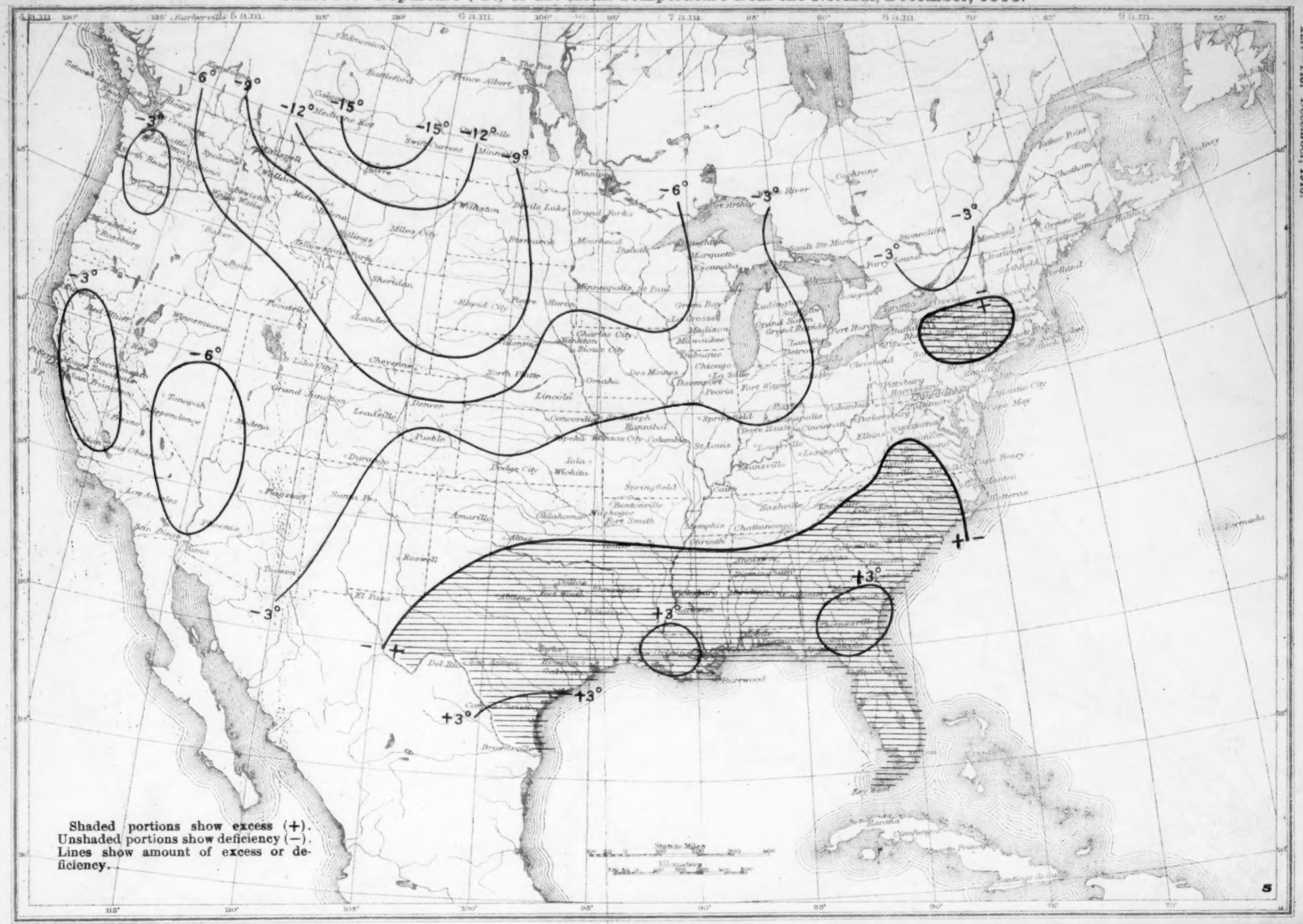

Chart V. Total Precipitation, December, 1916.

Chart V. Total Precipitation, December, 1916.

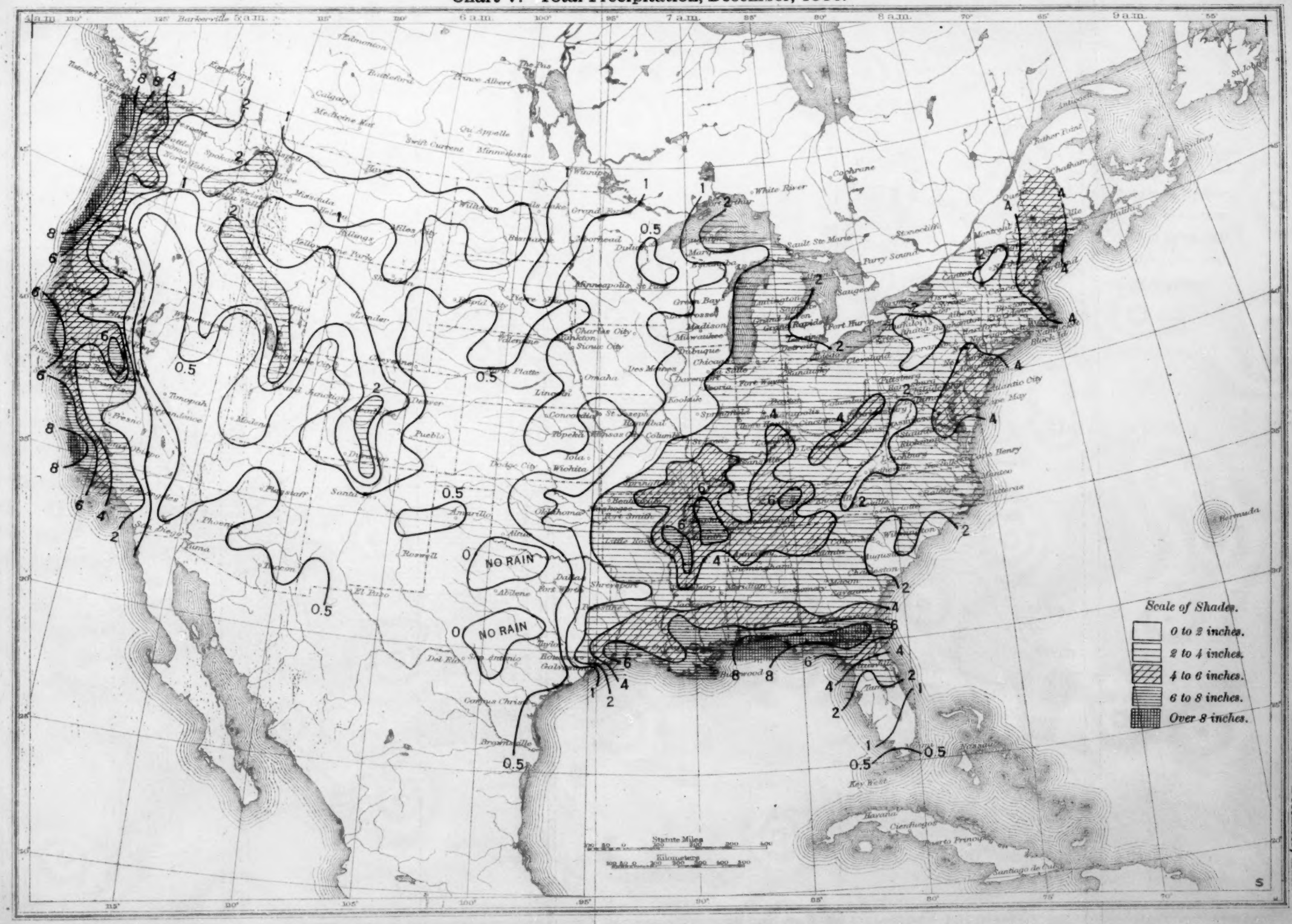

Chart VI. Percentage of Clear Sky between Sunrise and Sunset, December, 1916.

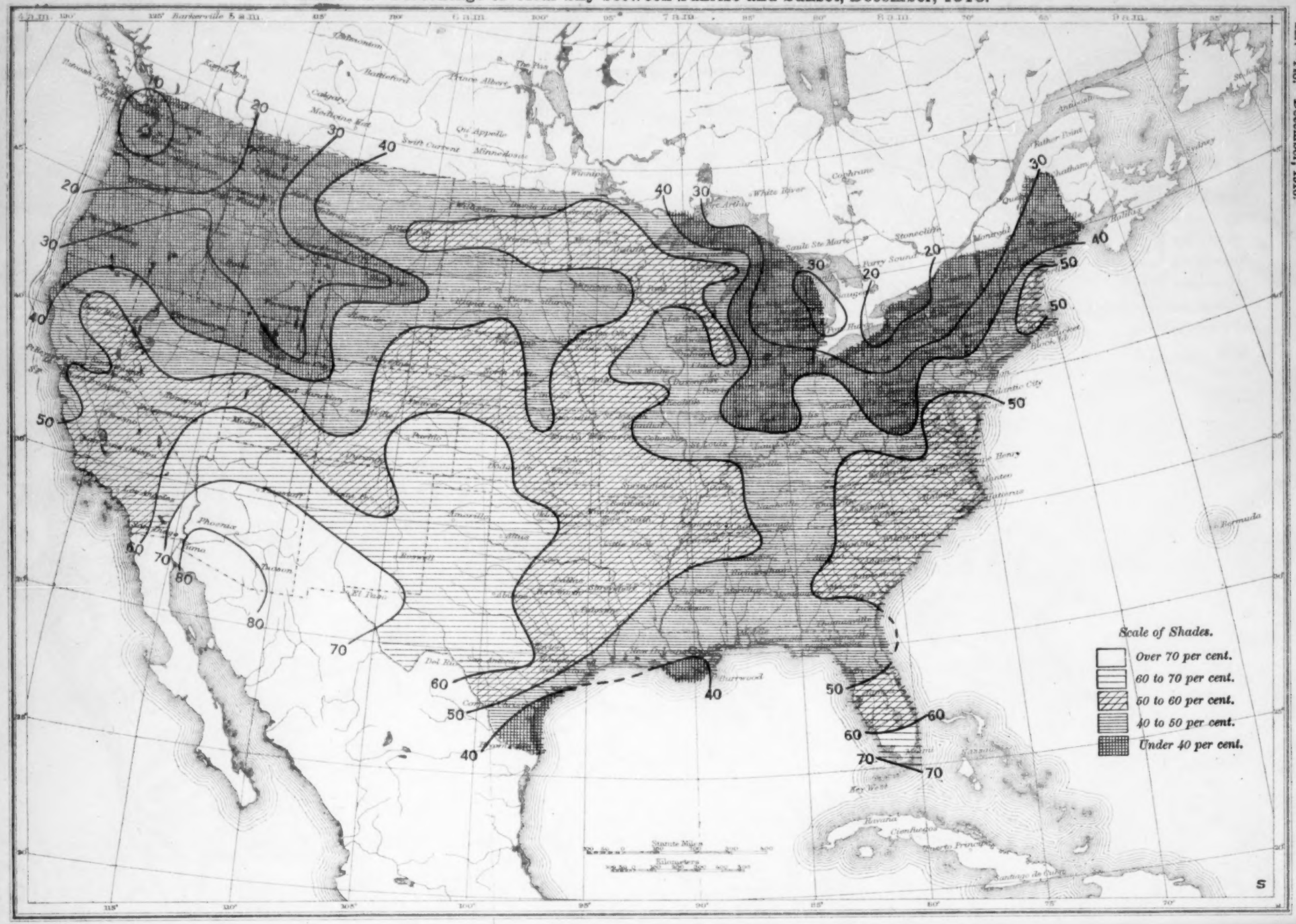

Chart VII. Isobars and Isotherms at Sea Level; Prevailing Winds, December, 1916.

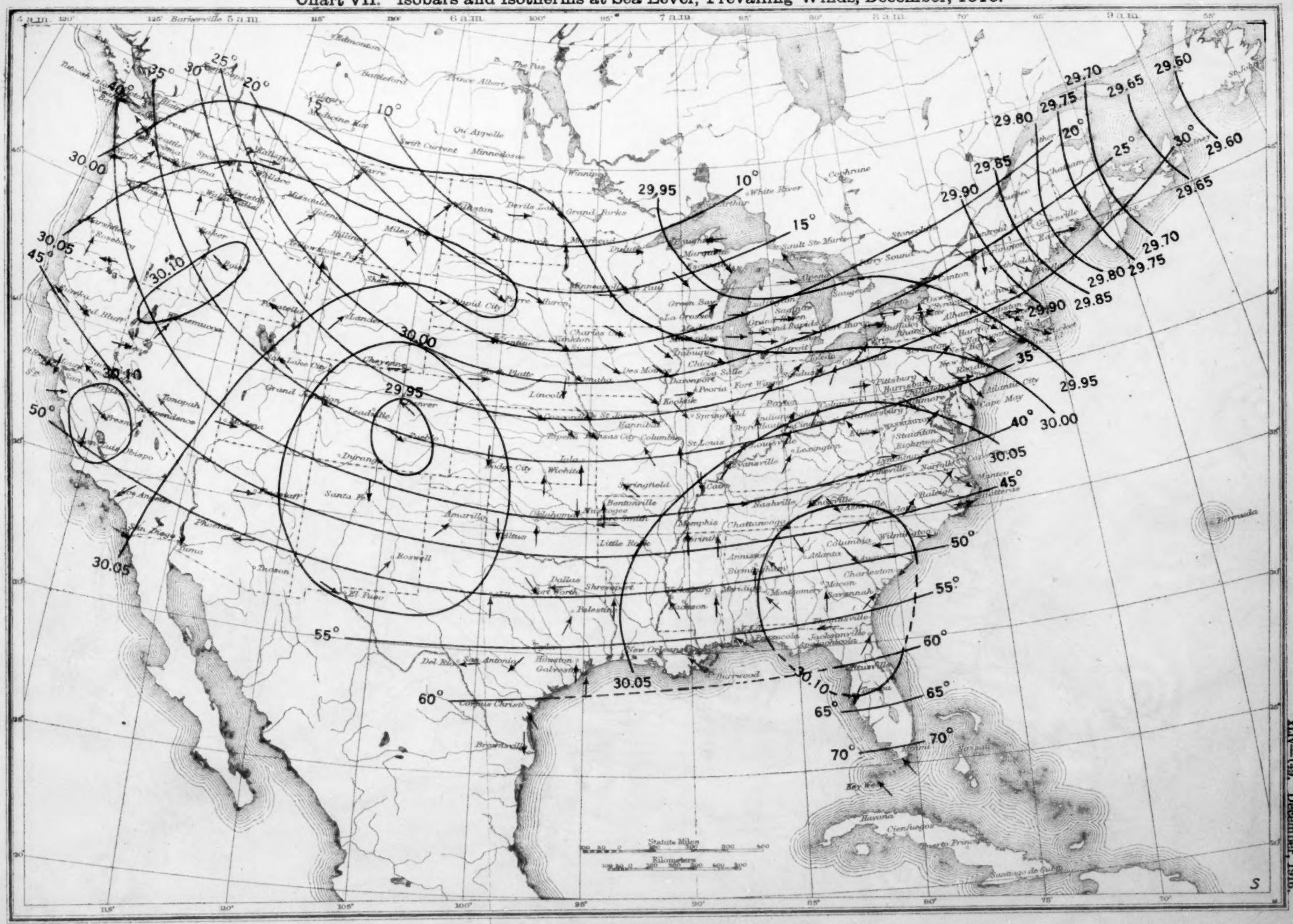

Chart VIII. Total Snowfall, Inches, December, 1916.

Chart IX. Means of Meteorological Data for North Atlantic Ocean, December, 1915.

(Plotted by F. A. Young.)

Chart IX. Means of Meteorological Data for North Atlantic Ocean, December, 1915.

(Plotted by F. A. Young.)

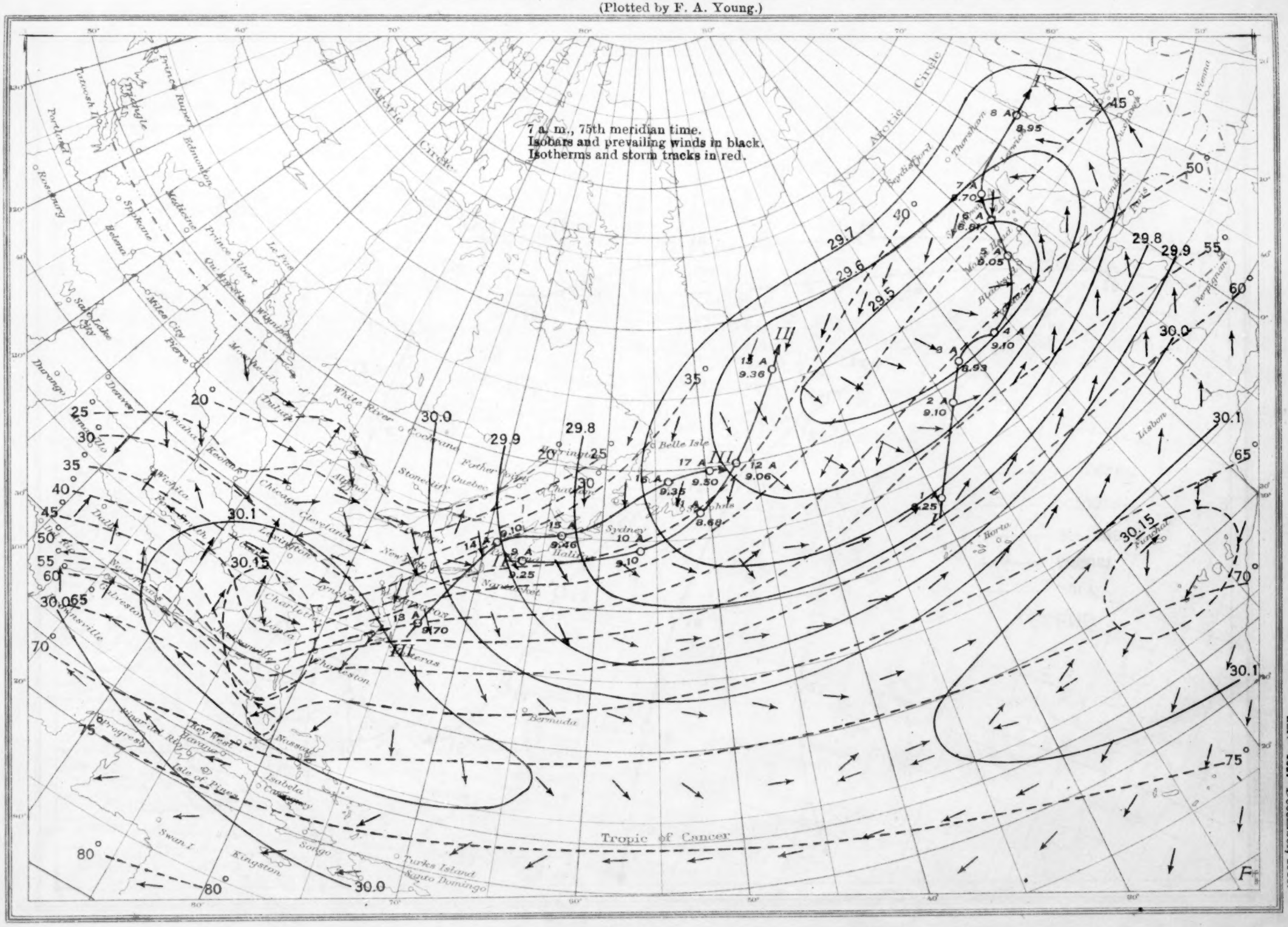
7 a. m., 75th meridian time.
Isobars and prevailing winds in black.
Isotherms and storm tracks in red.
Arctic Circle
Antarctic Circle
Tropic of Cancer
Bermuda
Belle Isle
Kingston
Havana
Key West
Nassau
Turks Island
Santo Domingo
Lisbon
Portland
Chicago
Cleveland
Pittsburg
Buffalo
Toronto
Montreal
Quebec
Boston
New York
Philadelphia
Washington
Charleston
Atlanta
Jacksonville
Galveston
Denver
Omaha
Duluth
Winnipeg
Salt Lake City
Miles City
Pierre
Bismarck
Portland
Roseburg
Spokane
Edmonton
Prince Albert
Qu'Appelle
Moose Jaw
Medicine Hat
Battleford
Prince Rupert
Dawson
Port Simpson
Sydney
Halifax
Father Point
Stonewall
Swan I.
Isle of Pines
Isabela
Songo
Progreso
Tampico
Vera Cruz
Hatteras
Cape Fear
Cape Henry
Block Island
Nantucket
Sable I.
Thorshavn
Valentia
Shetland
Perpignan
Biarritz
Gibraltar
Funchal
Horta
Ponta Delgada
29.7
29.6
29.5
29.8
29.9
30.0
30.1
30.15
30.065
30.2
30.3
30.4
30.5
30.6
30.7
30.8
30.9
31.0
31.1
31.2
31.3
31.4
31.5
31.6
31.7
31.8
31.9
32.0
32.1
32.2
32.3
32.4
32.5
32.6
32.7
32.8
32.9
33.0
33.1
33.2
33.3
33.4
33.5
33.6
33.7
33.8
33.9
34.0
34.1

Chart X. Hurricanes of 1916.

(Plotted by R. H. Weightman.)

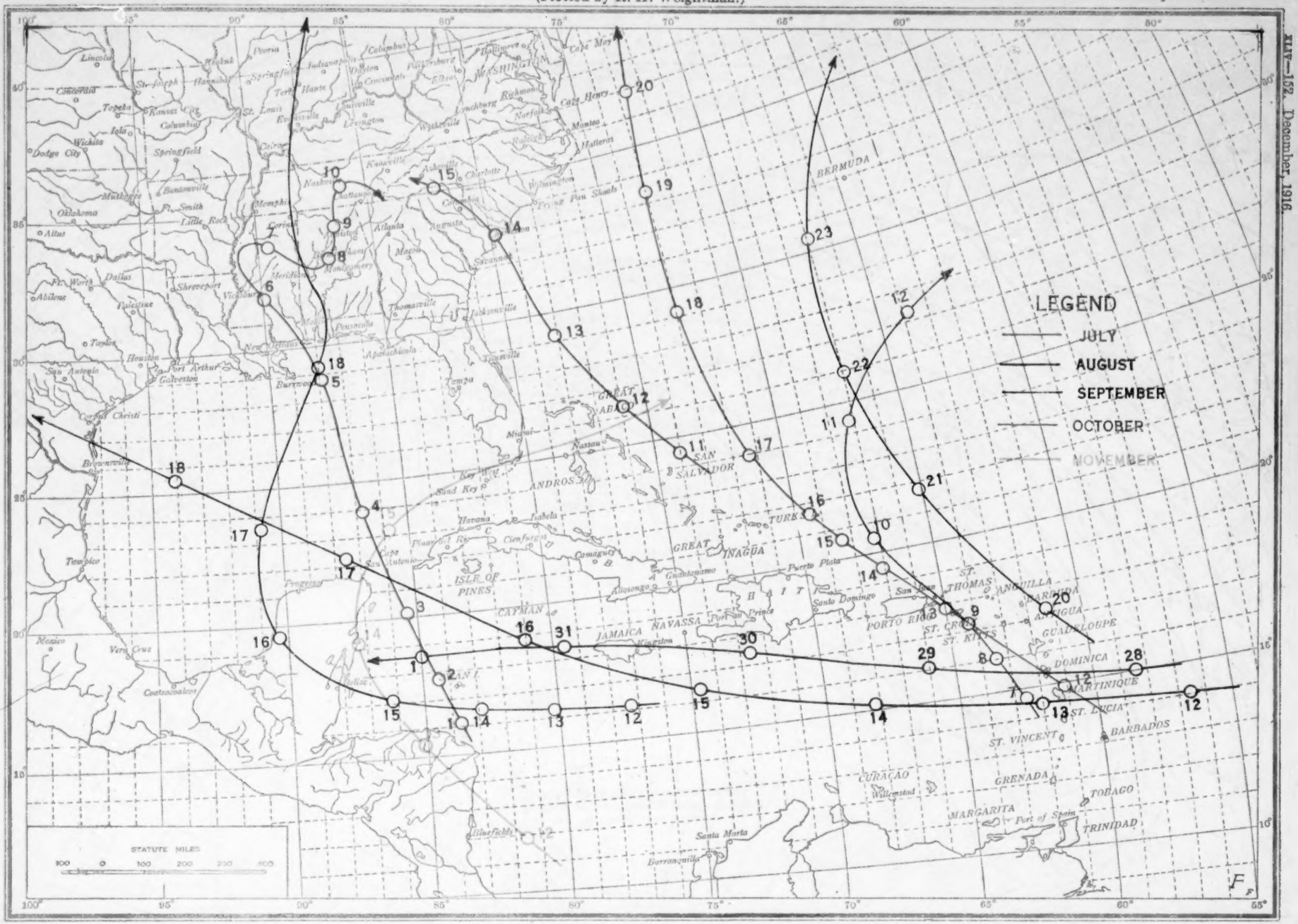

Chart XI. Earthquakes of 1916.

Chart XI. Earthquakes of 1916.